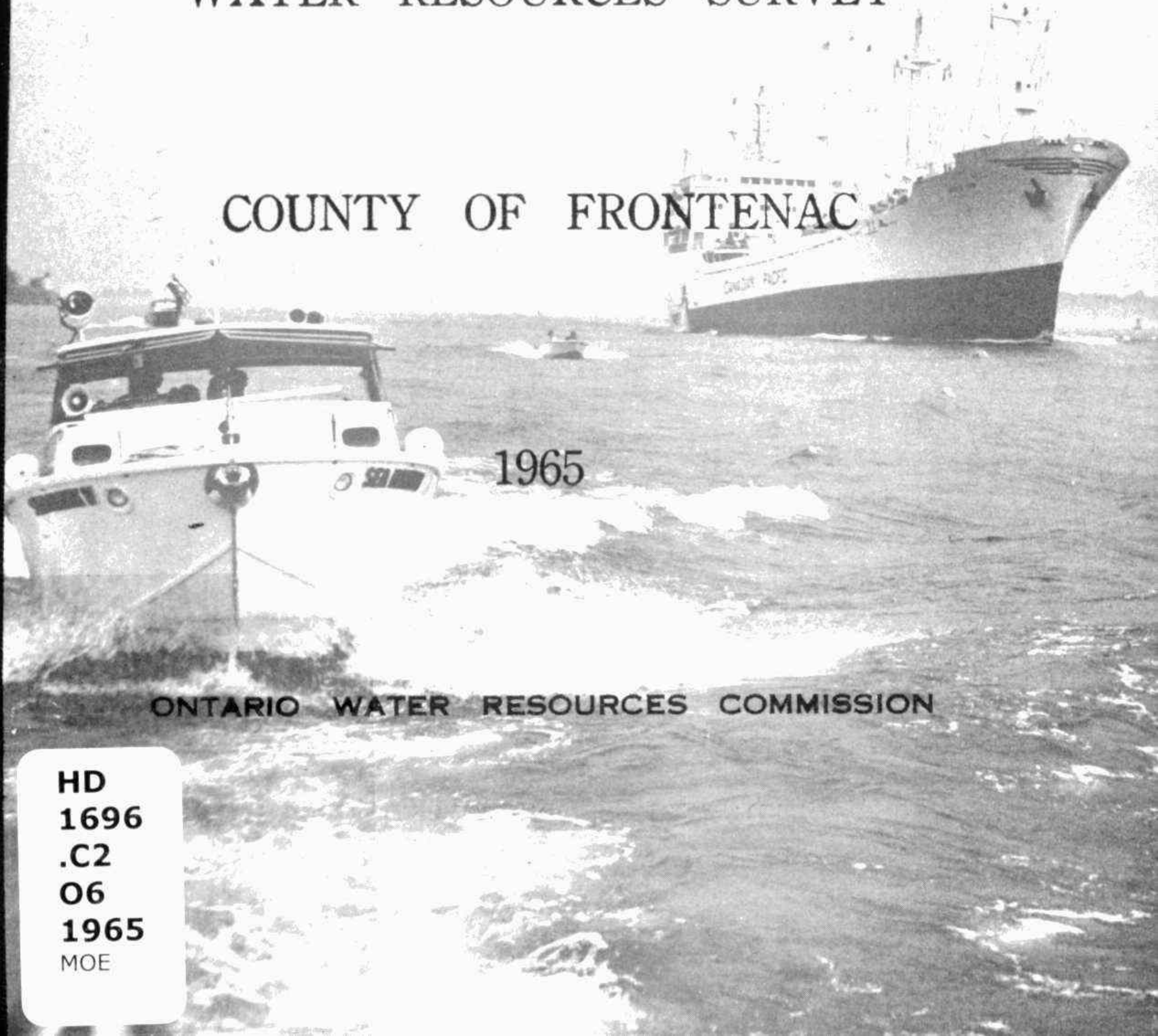
BBBS

Report on

WATER RESOURCES SURVEY

COUNTY OF FRONTENAC

1965



ONTARIO WATER RESOURCES COMMISSION

BBBS

A

Water Resources Survey

of the

County of Frontenac

1965

GENERAL TABLE OF CONTENTS

LIST OF FIGURES

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ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS

Engineering Terms

Ac. ft.	acre-feet
BOD	biochemical oxygen demand
cfs	cubic feet per second
F.	Fahrenheit
ft.	feet
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
M.F.	Membrane Filter
mg	million gallons
mgd	millions gallons per day
mi.	miles
ml	millilitre
MPN	Most Probable Number
pH	hydrogen ion concentration
ppb	parts per billion
ppm	parts per million
sq. ft.	square feet
sq. mi.	square mile

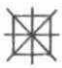
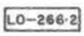
Proper Names

CN	Canadian National
HEPC	Hydro Electric Power Commission
OWRC	Ontario Water Resources Commission

Miscellaneous

avg.	average
cr.	creek
Conc.	Concession
cont'd	continued
Diss.	dissolved
lab.	OWRC laboratory
Ltd.	Limited
max.	maximum
min.	minimum
No.	number
Rd.	Road
St.	Street
Susp.	suspended
Twp.	Township

SYMBOLS

	Municipal Boundary
	Other Establishment
	Outfall
	Outfall Sampling Point Type D - Ditch I - Industrial S - Sanitary W - Storm T - Treated
	Refuse Disposal Site
	Sewage Pumping Station
	Sewage Treatment Plant (WPCP)
	Lake and River Sampling Point
	Water Works
	Bathing Area
	Streamflow Gauging Station

INTRODUCTION

PURPOSE

The Ontario Water Resources Commission is concerned with the management of water resources in the Province of Ontario, with particular attention to water supply and wastewater disposal. In this regard, the Commission carries out water resources surveys as means of ascertaining the needs of municipalities within a county unit or other defined areas.

The purpose of this report is to examine the conditions of the water resources of the County of Frontenac and indicate action required to ensure maximum use of those resources. This survey reviews the existing water and wastewater treatment facilities and indicates the requirements in developed areas which lack adequate facilities.

Recommendations are made concerning general policies to be followed in the use of these resources, with specific recommendations for each municipality.

SCOPE

The first three chapters deal generally with the county and the pertinent legislation. Subsequent chapters are devoted to water supply and wastewater disposal problems in municipalities. Several municipalities with similar interests or degrees of development are grouped into suitable chapters.

Conclusions based on the information presented in the survey are included at the end of each chapter. The summary and recommendations resulting from these conclusions constitute the first chapter.

The maps and figures outline ground-water availability, municipal water and sewage areas, stream gauging stations, sampling points on the main watercourses, and the major sources of pollution.

CHAPTER 1

SUMMARY AND RECOMMENDATIONS

CHAPTER 1

SUMMARY AND RECOMMENDATIONS

I SUMMARY

The County of Frontenac had a 1964 population of 81,143 persons, distributed throughout one city and 15 townships. Eighty-two per cent of the population resides in the three most southerly municipalities, the City of Kingston, and the townships of Kingston and Pittsburgh.

The shorelines of Lake Ontario and the St. Lawrence River form the southern boundary of the county. These waters provide an ideal and preferred supply for municipal, industrial and other purposes.

Navigation, hydro-electric power, and conservation requirements have involved extensive use of the inland surface-water resources. Many lakes, rivers, and streams attract and sustain significant tourist and recreational activities. These resources will support continued development, however, only if effective conservation and pollution control measures are pursued.

With regard to water supply systems, municipal, industrial, institutional, and privately operated water works are employed in and adjacent to the City of Kingston in the townships of Kingston and Pittsburgh. In the remainder of the county wells or springs are used to serve individual premises.

Surface water is the essential source of supply for municipal and industrial needs in the urban section of the county. The City of Kingston water works is well located to serve the growing and potential water supply needs in the southern area. As the continuing growth in the Township of Pittsburgh requires a satisfactory water supply, consideration should be given to a municipal water system. The feasibility of securing a suitable connection to the City of Kingston water supply system should be given full consideration.

Ground water is widely used in the rural parts where most private supplies are obtained from dug and drilled wells. There have been no indications that large urban developments will occur in the central and northern sections of the county. For this reason drilled wells will continue

to provide, in most cases, adequate supplies for individual homes and small communal systems.

Municipal sewage treatment plants are operated by the city and the Township of Kingston. The city plant is of the primary type whereas the township plant serving the main built-up areas provides secondary treatment. In the Township of Pittsburgh, a public institution at Joyceville, and the Cana Home Builders Co-Operative Subdivision employ, respectively, a secondary sewage treatment plant and a septic tank with an underdrained tile bed. Elsewhere in the county individual subsurface disposal systems are used to handle domestic wastes.

Industrial wastes originating from factories within the City of Kingston and the Township of Kingston are, except in a few instances in the city, directed to municipal sewage works. An intensive programme of control is required to eliminate pollution from untreated or partially treated discharges of wastes involving four industries in the city.

There are four cheese factories in the county, two of which have not made suitable provision for wastewater disposal.

Surface water quality in the county is generally satisfactory. However, high coliform concentrations are encountered in the raw water supply of the City of Kingston and downstream from the sewage treatment plant. In the case of the water supply the high bacteriological counts are intermittent and are probably related to overflows from combined sewers and industrial waste discharges to the Cataraqui River. Material resembling gross sewage solids has been observed from time to time in the river below the Kingston sewage treatment plant, and is believed to be related to overflows from combined sewers serving the older part of the city.

The need for an investigation by the city of the extent of these discharges and implementation of necessary corrective measures is indicated. The adverse bacteriological conditions in the river also will be improved by the installation of chlorination equipment at the sewage treatment plant for effluent disinfection. Experiences with abundant algae and other aquatic plant growths have been reported. These growths create operational problems for the water works systems in the area, interfere with boating and swimming, and create objectionable nuisance conditions.

The Ontario Water Resources Commission is actively engaged in research studies of methods for the control of algal growths and factors contributing to their growth.

Cases of ground-water pollution have been noted in the more developed townships of Kingston and Pittsburgh. For the most part, these problems have been caused by private sewage disposal systems, but two were caused by seepage of gasoline. In the Township of Kingston seepage from septic tank systems was the likely cause of high coliform concentrations noted along a section of Lake Ontario during the summer months.

Because of the general heavy nature and shallow depth of soil in the county, planning for future subdivision development should be considered only on the basis of public sewage systems.

II RECOMMENDATIONS

General

1. Where possible, joint use by neighbouring municipalities of water and sewage works should be considered.

2. Subdivisions should be developed only on the basis of public sewage systems.

3. All municipalities, industries, and others responsible for wastewater discharges should support and encourage pollution control programmes.

City of Kingston

Water Supply

1. The need for expanding the capacity of the water filtration plant should be considered within the next five years.

2. The city should give consideration to the possibility of supplying water to future developments in the Township of Pittsburgh.

Pollution Control

1. The municipality should take adequate steps to eliminate pollution from overflow structures, particularly in the vicinity of the water works. In this instance, the adequacy of the lakefront interceptor sewer should be checked.

2. Effluent chlorination facilities should be installed at the sewage treatment plant as soon as possible.

3. All water-borne wastes from the A. Davis and Son Limited tannery, the Aluminum Company of Canada, the Canadian Locomotive Company Limited, the Frontenac Floor Tile, and the Cataraqui Golf and Country Club should be adequately treated before being released to any watercourse.

4. Consideration should be given to the possibility of joint planning of water pollution abatement programmes with the Township of Pittsburgh.

Township of Kingston

Water Supply

1. The chlorination facilities at the Westbrook Heights water works should be improved.

2. The three existing water distribution systems should be integrated and plans made for development and reinforcement of the system.

3. Early consideration should be given to the construction of a water filtration plant.

Pollution Control

1. Sanitary sewers should be extended as soon as possible to serve the developed area of the township.

2. Expansion of the municipal sewage treatment plant should be considered within the next five years.

Township of Pittsburgh

Water Supply

1. A preliminary engineering report should be prepared on the future development of a municipal water system.

2. The possibility of securing a suitable connection to the City of Kingston water supply system to serve developing areas in the township should be investigated.

Pollution Control

1. A preliminary engineering report should be prepared for the development of a municipal sewerage system.

2. Sanitary sewers should be installed in the developed section of the township.

3. Consideration should be given to the development of joint sewage treatment arrangements with the City of Kingston, utilizing the city's sewage treatment plant.

Townships of Barrie, Clarendon and Miller, Palmerston and North and South Canonto

There are no recommendations.

Townships of Bedford and Hinchinbrooke

Township of Hinchinbrooke

Pollution Control

1. A suitable industrial waste disposal system should be provided by the Parham Cheese factory.

Townships of Howe Island and Wolfe Island

There are no recommendations.

Townships of Kennebec, Olden, and Oso

There are no recommendations.

Township of Loughborough

There are no recommendations.

Township of Portland

There are no recommendations.

Township of Storrington

Pollution Control

1. Suitable arrangements for industrial waste disposal should be provided by the Battersea and Sunbury Cheese factories.

CHAPTER 2

GEOGRAPHY AND GEOLOGY

CHAPTER 2

GEOGRAPHY AND GEOLOGY

I GEOGRAPHY

1. Topography

As the overburden deposits throughout much of the county are thin, the underlying bedrock exerts a major influence on the topography. In the céntral and northern parts of the county, the topography is rugged and irregular. Due to differential weathering, bedrock ridges generally follow the strike of the more resistant formations and depressions follow faults and strikes of less resistant formations. The ruggedness of the terrain is lessened to some degree by the overburden deposits within the depressions. In the south, the topography comprises mainly a gently sloping, flat to undulating plain reflecting the attitude of the bedrock surface.

Local relief of the Precambrian bedrock is in the order of 100 feet, and occasionally exceeds 300 feet. The bedrock surface slopes from a maximum elevation of 1,250 feet above sea level in the Township of Miller to about 246 feet in the Township of Pittsburgh. The Palaeozoic limestone plain slopes regionally in the direction of Lake Ontario from an elevation of about 650 feet above sea level in the Township of Loughborough to 246 feet in the Township of Wolfe Island. Relief of the plain is low, locally in the order of 50 feet, except in the regions of bedrock valleys where it may exceed 100 feet.

2. Drainage

The general drainage pattern shown in Figure 2-1 is controlled by bedrock formations. These formations and glacial action have contributed to the many lakes in the region. A number of relatively major drainage systems flow through or originate in the county. In the north, drainage is in a north-easterly direction toward the Ottawa River via the Madawaska, Mississippi, and Rideau systems, and their connecting lakes and tributaries. A central-western fringe drains south-westerly through the Moira, Salmon, and Napanee rivers to the Bay of Quinte. The southern third of the county drains to the Lake Ontario-St. Lawrence River system through such streams as Millhaven Creek, Collins Creek, Little Cataraqui Creek, Cataraqui River, and the

Gananoque River. Table 2-1, entitled Drainage Areas within the County of Frontenac, shows the distribution of the county area according to outlet and discharge streams.

Table 2-1

Drainage Areas Within the County of Frontenac by Outlet

Outlet and Stream	Drainage area in sq. miles Total System	Individual
Ottawa River	787	
Madawaska River		139
Mississippi River		491
Rideau River		157
Lake Ontario-St.Lawrence River	843	
Moira River		14
Salmon River		126
Napanee River		162
Millhaven Creek		42
Collins Creek		60
Little Cataraqui Creek		24
Cataraqui River		274
Gananoque River		25
Miscellaneous		116

NOTE: Drainage areas determined from topographic maps. Scale 1:50,000

There are many artificial drainage controls in the county. Although many early dams and reservoirs constructed for logging and milling operations have been abandoned, a number of dams are maintained for navigational, power, flood control, recreational, municipal, and industrial water supply purposes. In some instances diversions of other drainage systems have been arranged.

Agricultural drainage systems are used in the poorly or imperfectly drained clay and clay loam soils of the southern section.

In Figure 2-2 the drainage features and hydraulic structures including dams, navigation locks, hydro-electric generating stations, and gauging station are shown.

3. Climate

The climate is moderate. Table 2-2 shows long term precipitation and temperature data for four meteorological observation stations within or near the county as provided by the Meteorological Branch, Department of Transport. Monthly and annual averages are shown of precipitation and temperature under the sub-headings daily mean, daily maximum, and daily minimum temperature for designated periods of record ending in 1960.

Average annual precipitation ranges from 35.0 inches in the south to about 32.5 inches in the north. Considering seasonal variations, precipitation is fairly evenly distributed over the 12 months of the year. Mean monthly temperatures range from 18°F. in January to 70°F in July at Kingston, and 15°F in January to 69°F in July in the northern sections of the county.

4. Land Use

The total county land area covers 795,207 acres, of which about 155,000 acres are listed as improved acreage. These figures reflect the limited economic use made of land because of the rugged topography and lack of overburden.

Much of the land underlain by Palaeozoic bedrock in the southern section is used for agricultural purposes. In that part encompassing the townships of Portland, Loughborough, Storrington, and Pittsburgh, most farmland is utilized as pasture due to the relative shallowness of overburden. More substantial thicknesses of clay overburden in the townships of Kingston, Howe and Wolfe Islands have allowed the successful cultivation of field crops such as wheat, hay, oats, and corn. Urban development around the City of Kingston has significantly reduced the percentage of productive farmland within the Township of Kingston.

The greater part of the county is underlain by Precambrian bedrock, and, because of irregular, hummocky terrain and lack of overburden, is used very little for agricultural purposes.

TABLE 2-2

CLIMATIC NORMALS OF PRECIPITATION AND TEMPERATURE

FOR REPRESENTATIVE STATIONS

DAILY MEAN TEMPERATURE - MONTHLY AND ANNUAL AVERAGES IN DEGREES FAHRENHEIT

Station	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Bancroft	1931-1960	14.1	14.1	23.7	37.3	51.7	60.9	65.3	63.5	54.4	43.0	31.4	18.1	39.8
Kingston	1931-1960	18.2	19.1	29.1	43.2	54.6	64.5	70.0	68.8	60.8	49.5	37.3	23.5	44.9
Port Elmsley	1952-1960	15.6	20.7	27.1	44.4	56.1	65.1	68.9	67.2	59.6	46.7	37.2	23.4	44.3

DAILY MAXIMUM TEMPERATURE - MONTHLY AND ANNUAL AVERAGES IN DEGREES FAHRENHEIT

Station	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Bancroft	1931-1960	22.4	23.7	33.5	46.6	63.8	72.9	77.3	75.9	66.6	53.7	38.4	25.7	50.0
Kingston	1931-1960	26.0	26.9	36.6	52.2	64.5	74.1	80.0	79.0	70.0	58.7	44.7	30.7	53.6
Port Elmsley	1952-1960	26.8	29.6	35.6	53.9	68.4	76.3	80.6	79.1	70.3	56.8	44.7	31.3	54.4

DAILY MINIMUM TEMPERATURE - MONTHLY AND ANNUAL AVERAGES IN DEGREES FAHRENHEIT

Station	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Bancroft	1931-1960	5.8	4.4	13.9	28.0	39.5	48.8	53.2	51.1	42.1	32.3	24.3	10.5	29.5
Kingston	1931-1960	10.4	11.3	21.6	34.2	44.7	54.9	60.0	58.6	51.6	40.3	29.9	16.3	36.2
Port Elmsley	1952-1960	5.0	11.7	18.6	34.9	43.7	53.9	57.1	55.2	48.9	36.6	29.7	15.5	34.2

TABLE 2-2 (Cont'd)

CLIMATIC NORMALS OF PRECIPITATION AND TEMPERATURE

FOR REPRESENTATIVE STATIONS

PRECIPITATION - MONTHLY AND ANNUAL AVERAGES IN INCHES

Station	Period of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Bancroft	1931-1960	2.59	1.68	2.68	2.31	2.42	2.61	2.85	2.41	3.31	2.64	2.93	2.76	31.14
Dalhousie Lake	1931-1960	2.53	2.16	2.76	2.78	2.89	2.94	2.88	2.49	3.01	2.64	2.74	2.70	32.52
Kingston	1931-1960	2.79	2.41	2.80	2.80	2.99	2.56	3.08	2.96	3.34	2.96	3.10	3.26	35.05
Port Elmsley	1948-1960	2.80	2.90	2.47	3.02	2.82	2.58	2.77	4.33	2.80	2.64	2.67	2.83	34.63

NOTE: Table prepared from records supplied by the Meteoriological Branch, Department of Transport, Canada.

5. Population

The population of the county is 81,143 persons, 66,776 or 82 per cent of which is located in the City of Kingston and the townships of Kingston and Pittsburgh. It is interesting to note that in 1949 these three municipalities accounted for 75 per cent of the county population.

Considering the 1954 population of 63,815 persons, a 24 per cent increase has occurred during the last ten years. Using this growth rate it may be anticipated that by 1974 100,000 persons will reside in the county.

II GEOLOGY

1. Bedrock

The bedrock formations are of Precambrian and Palaeozoic ages. Approximately four-fifths of the area is Precambrian bedrock as illustrated in Figure 2-3.

The Precambrian bedrock consists of bands of varied thicknesses of basic and acidic volcanic rocks and metasedimentary rocks composed essentially of marble, quartzite, schist, and gneiss. Basic and acidic rocks ranging in composition from gabbro to granite have been intruded into the other formations. Faulting and folding have given rise to the bedrock structure. The folds in the metasedimentary rocks trend in a north-easterly direction, and tend to plunge easterly at angles up to 30 degrees. Some beds dip steeply, some are overturned, however, most have dips of less than 45 degrees. The intrusive bodies generally are irregular in shape and dimension, and exhibit little structure.

Directly overlying the Precambrian surface in the south are rocks of Palaeozoic age, in particular, the Potsdam sandstone and the Black River limestone. These formations have a gentle regional dip in a south-westerly direction.

The geologic succession of the Palaeozoic formations is as follows:

Period	Formation	Description
Ordovician	Black River	Mainly grey limestone; basal beds of red argillaceous limestone and shale.

Period	Formation	Description (Cont'd)
Upper Cambrian	Potsdam	Reddish brown sandstone; basal conglomerate.

Outcroppings of Black River limestone are extensive throughout the south-west. The Potsdam sandstone outcrops mainly in the townships of Storrington and Pittsburgh, and is known to underlie the limestone in several other locations.

2. Overburden

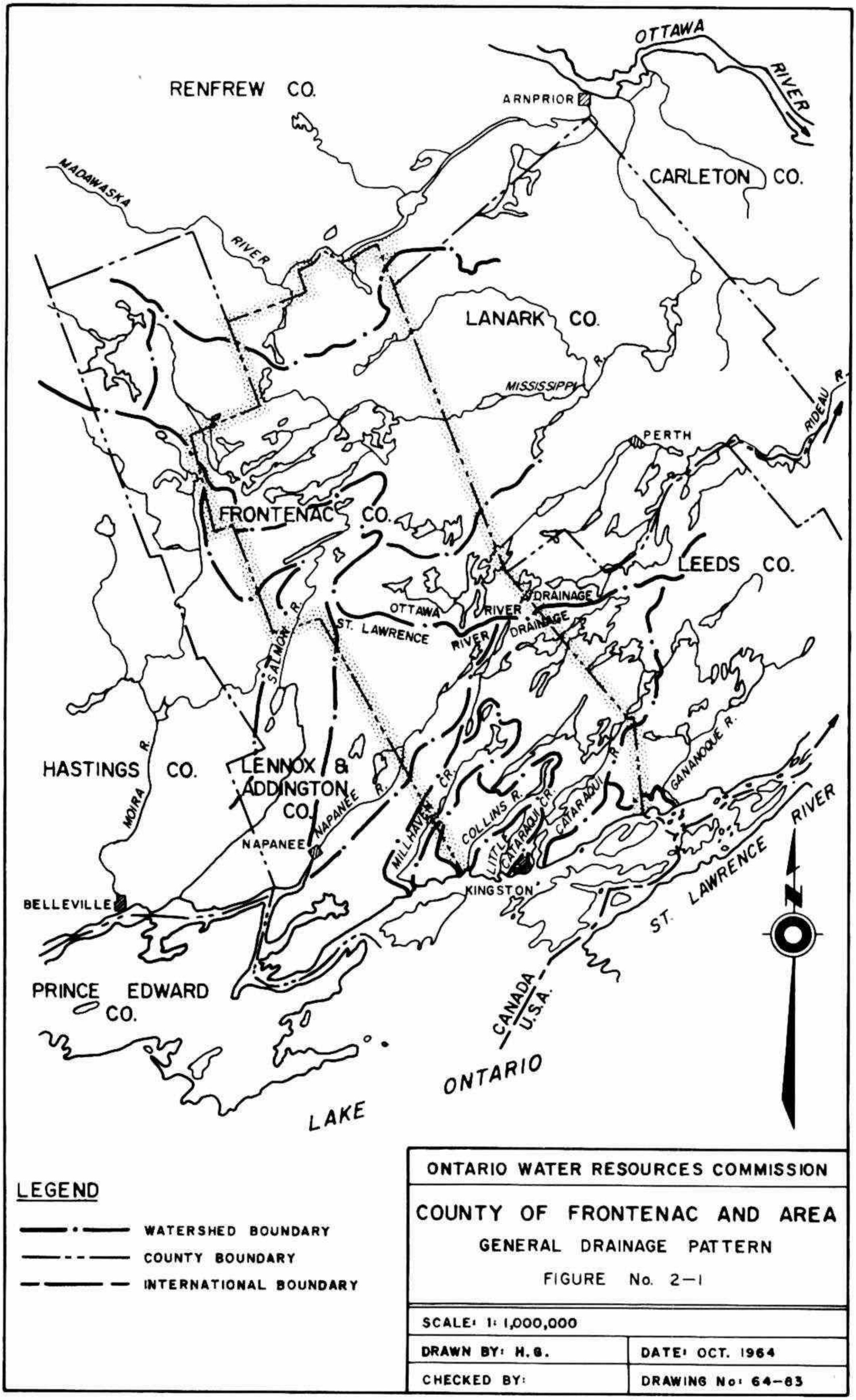
The overburden of the area was deposited during glaciation and deglaciation in Pleistocene times. The principal deposits are in the form of ground and recessional moraines laid down by ice; outwash and kame moraines formed by discharging glacial meltwaters; and clay and beach deposits related to glacial lakes.

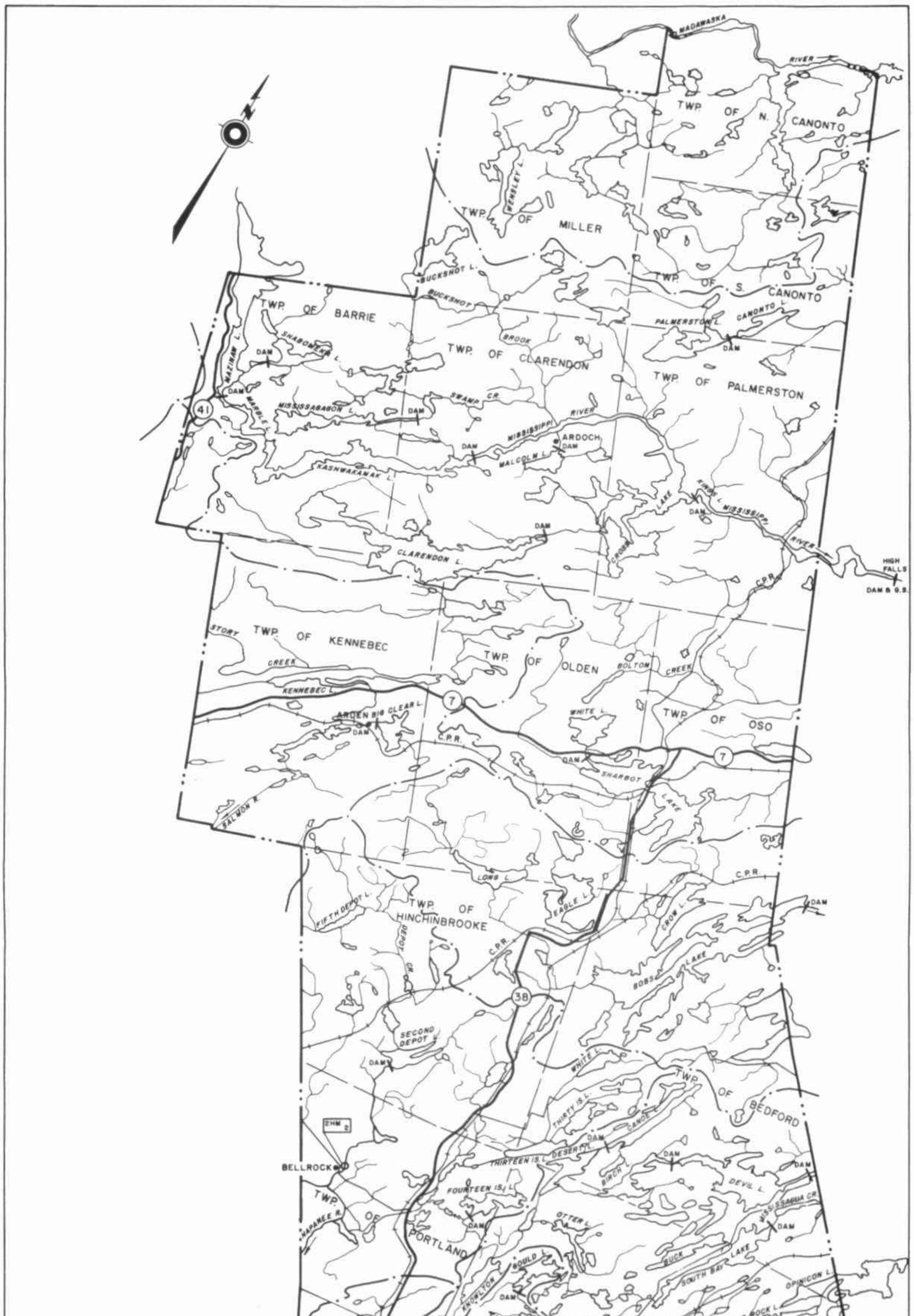
The materials deposited by ice are referred to as till and consist of poorly-sorted mixtures of clay, silt, sand, gravel, and boulders. Much of the overburden material is in the form of ground moraine generally five to six feet in thickness with greater accumulations in some bedrock depressions. Recessional moraine ridges of low relief and sandy till composition are present in various areas of the county.

Glacio-fluvial deposits in the form of spillways generally consist of silt, sand, and gravel. These materials are also present in kame moraines which may also contain some till and were formed largely by deposition of materials from waters at the melting ice-front. Spillway deposits were formed farther from the ice-front and are found generally in the lower topographic areas. Kames are conspicuous due to a relief characteristic of irregularly shaped knolls or hummocks. The size and degree of sorting of the deposit materials are quite variable. The sand and gravel deposit in the Bon Echo area extending through Cloyne and terminating in the form of a minor delta in the vicinity of Bishop's Corners appears to be in a major spillway.

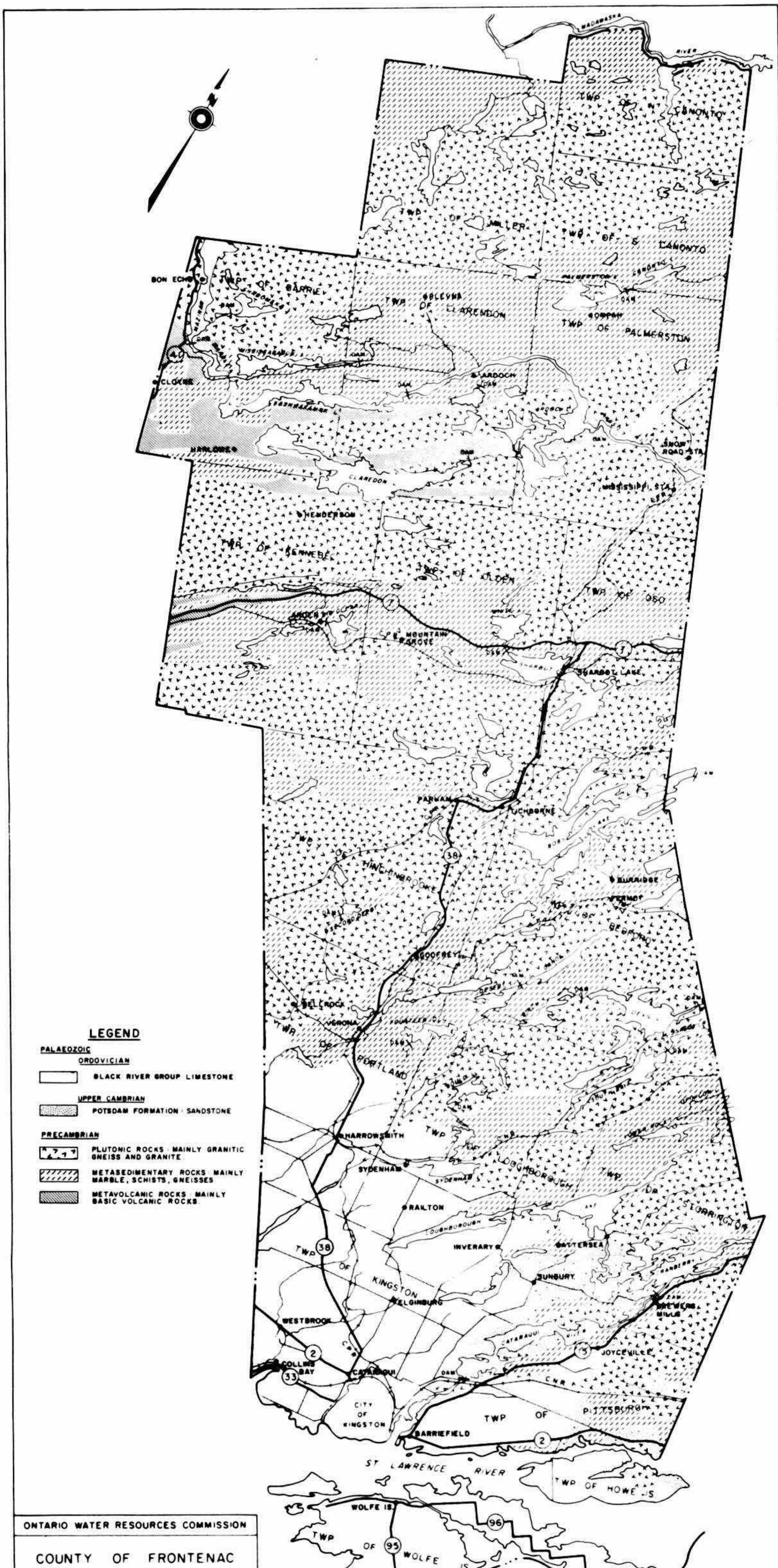
The materials deposited in the glacial lakes are largely fine-grained clays and silts, however, several coarse-grained sand and gravel beaches and bars were developed around the margins of the lakes during various glacial phases. Deposition of such materials occurred mainly in the southern section of the county during melting of the last ice sheet.

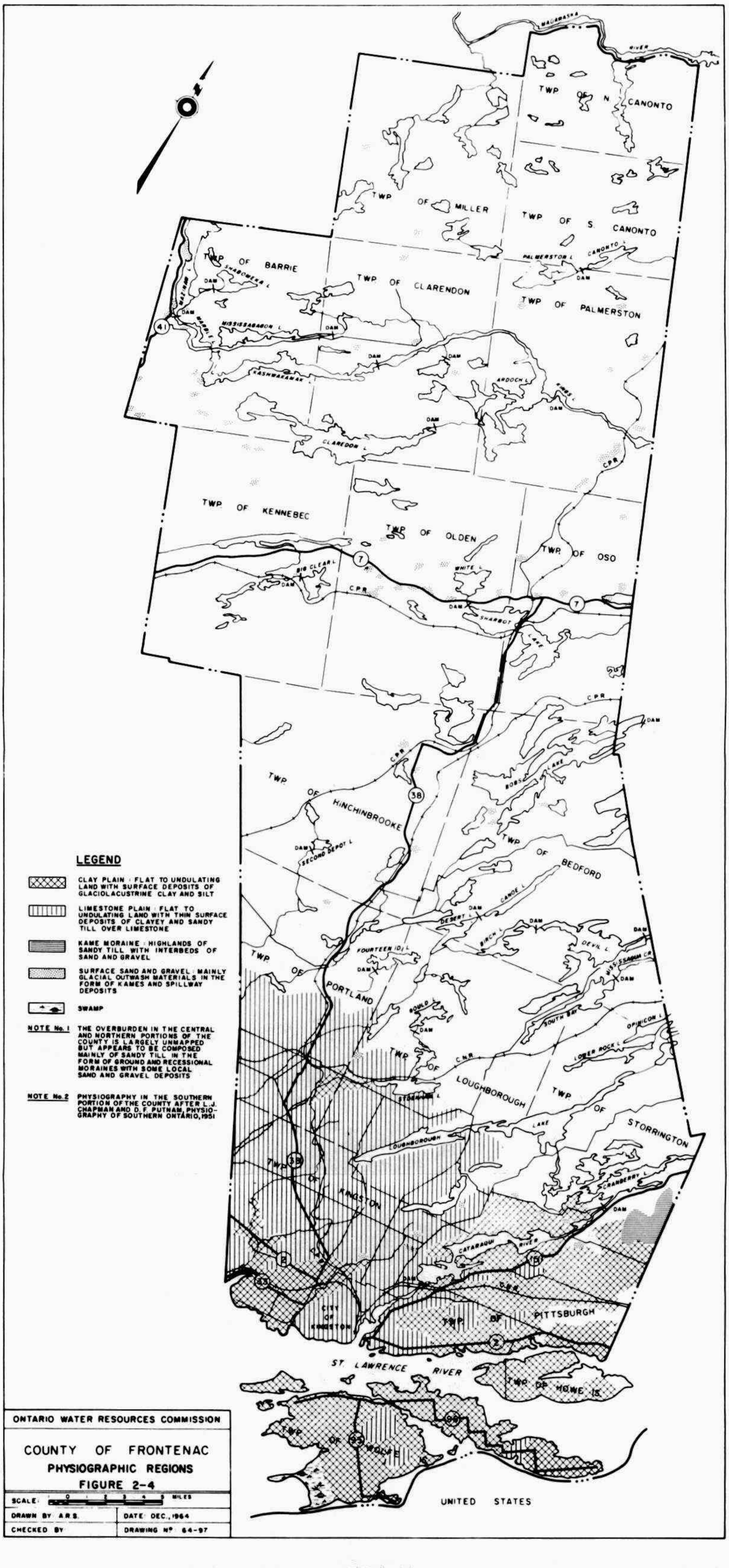
Figure 2-4, entitled Physiographic Regions, illustrates the distribution of overburden deposits in the southern part of the county and the locations of a number of sand and gravel deposits that were observed in the northern areas during the survey.


OTTAWA
RIVER
RENFREW CO.
ARNPRIOR
MADAWASKA
RIVER
CARLETON CO.
LANARK CO.
MISSISSIPPI R.
RIDEAU R.
PERTH
FRONTENAC CO.
LEEDS CO.
DRAINAGE
OTTAWA RIVER DRAINAGE
ST. LAWRENCE RIVER DRAINAGE
SALMON R.
HASTINGS CO.
LENNOX & ADDINGTON CO.
MOIRA R.
NAPANEE R.
NAPANEE
MILLHAVEN CR.
COLLINS R.
LITTLE CATARAQUI CR.
CATARAQUI R.
GANANOQUE R.
KINGSTON
BELLEVILLE
ST. LAWRENCE RIVER
PRINCE EDWARD CO.
CANADA U.S.A.
LAKE ONTARIO
LEGEND
WATERSHED BOUNDARY
COUNTY BOUNDARY
INTERNATIONAL BOUNDARY
ONTARIO WATER RESOURCES COMMISSION
COUNTY OF FRONTENAC AND AREA
GENERAL DRAINAGE PATTERN
FIGURE No. 2-1
SCALE: 1: 1,000,000
DRAWN BY: H.G.
DATE: OCT. 1964
CHECKED BY:
DRAWING No: 64-83


LEGEND
TOWNSHIP LINE
COUNTY LINE
DRAINAGE DIVIDE
DAM
STREAM FLOW GAUGING STA.
LOCKS AND NUMBER OF LOCKS.
GENERATING STATION
ONTARIO WATER RESOURCES COMMISSION
COUNTY OF FRONTENAC
FIGURE 2-2
DRAINAGE PATTERN AND DIVIDES, LOCATION OF STREAMFLOW GAUGING STATION, CONTROL WORKS.
SCALE: 1 0 1 2 3 4 5 MILES
DRAWN BY: A.R.S.
DATE: DEC., 1964
CHECKED BY: W.L.
DRAWING Nº: 64-97
MADAWASKA RIVER
TWP. OF N. CANONTO
TWP. OF MILLER
TWP. OF S. CANONTO
TWP. OF BARRIE
TWP. OF CLARENDON
TWP. OF PALMERSTON
MISSISSIPPI RIVER
ARDOCH
HIGH FALLS DAM & G.S.
TWP. OF KENNEBEC
TWP. OF OLDEN
TWP. OF OSO
SHARBOT LAKE
TWP. OF HINCHINBROOKE
TWP. OF BEDFORD
BELLROCK
TWP. OF PORTLAND
TWP. OF LOUGHBOROUGH
TWP. OF STORRINGTON
TWP. OF KINGSTON
BREWERS MILLS
WASHBURN
KINGSTON MILLS
CITY OF KINGSTON
TWP. OF PITTSBURGH
ST. LAWRENCE RIVER
TWP. OF HOWE IS.
TWP. OF WOLFE IS.
UNITED STATES

18


LEGEND
PALAEOZOIC
ORDOVICIAN
BLACK RIVER GROUP LIMESTONE
UPPER CAMBRIAN
POTSDAM FORMATION : SANDSTONE
PRECAMBRIAN
PLUTONIC ROCKS : MAINLY GRANITIC GNEISS AND GRANITE
METASEDIMENTARY ROCKS : MAINLY MARBLE, SCHISTS, GNEISSES
METAVOLCANIC ROCKS : MAINLY BASIC VOLCANIC ROCKS
ONTARIO WATER RESOURCES COMMISSION
COUNTY OF FRONTENAC
BEDROCK GEOLOGY
FIGURE 2-3
SCALE: 0 2 3 4 5 MILES
DRAWN BY A.R.S.
DATE DEC., 1964
CHECKED BY
DRAWING Nº 64-97
TWP OF N. CANONTO
TWP OF MILLER
TWP OF S. CANONTO
TWP OF BARRIE
TWP OF CLARENDON
TWP OF PALMERSTON
TWP OF KENNEBEC
TWP OF OLDEN
TWP OF OSO
TWP OF HINCHINBROOKE
TWP OF BEDFORD
TWP OF PORTLAND
TWP OF LOUGHBOROUGH
TWP OF STORRINGTON
TWP OF KINGSTON
TWP OF PITTSBURGH
TWP OF HOWE IS
TWP OF WOLFE IS
BON ECHO
CLOYNE
HARLOWE
ARDOCH
SNOW ROAD STA
MISSISSIPPI STA
HENDERSON
MOUNTAIN GROVE
SHARBOT LAKE
PARHAM
TICHBORNE
GODFREY
BELLROCK
VERONA
HARROWSMITH
SYDENHAM
RAILTON
INVERARY
BATTERSEA
SUNBURY
ELGINBURG
WESTBROOK
COLLINS BAY
CATARAQUI
CITY OF KINGSTON
BARRIEFIELD
JOYCEVILLE
BREWERS MILLS
WOLFE IS.
ST LAWRENCE RIVER
UNITED STATES



COUNTY OF FRONTENAC
PHYSIOGRAPHIC REGIONS
FIGURE 2-4

CHAPTER 3

WATER RESOURCES

CHAPTER 3

WATER RESOURCES

I INTRODUCTION

The extent and relative abundance of ground and surface waters have been important factors in the growth pattern of the county. Early development was encouraged by the networks of surface waterways which provided navigation routes for commerce and water power potential. These essential uses are reflected today in the St. Lawrence Seaway and the Rideau Canal System and the hydro-electric power developments. Ground-water sources are adequate for limited domestic requirements and only occasionally can be expected to be sufficient to supply small community needs. In addition to navigation, power, and recreation, surface waters provide important supply sources for existing and developing municipal and industrial water requirements. Drainage and use of surface waters for wastewater disposal are vital to the continuing development of municipalities and industries although these practices may conflict with other water uses.

The drainage pattern and streamflow gauging station are shown in Figure 2-2 along with many of the hydraulic works in and adjacent to the county. The sampling locations for water quality are shown in Figures 3-1 and 3-2.

II WATER MANAGEMENT LEGISLATION

The Provincial Government has recognized the problems which result from multiple and unlimited uses of water and the need for efficient management and control of water resources.

In 1961, a permit system* was introduced to provide for the fair sharing of the available supply of water and the alleviation of serious water-use interference problems.

In 1963, the Agricultural Rehabilitation Development Act (Ontario) was enacted to provide for cost-sharing agreements between the province and the Government of Canada on projects of development and conservation for agricultural

* Under Section 28a of The Ontario Water Resources Commission Act, the taking of water in an amount in excess of 10,000 gallons per day, with few exceptions, requires authorization by permit.

purposes. These include works and research related to conservation of soil and water.

Under The Conservation Authorities Act, conservation authorities may be established to carry out conservation programmes related to flood control, land use, forestry, wildlife, and recreation.

In 1964 the Minister of Energy and Resources Management announced a programme designed to encourage construction of farm ponds and water supply reservoirs. Subsidies amounting to 50 per cent of the construction costs, up to a maximum of $500, may be paid to individual farmers for farm ponds approved by the Department of Agriculture. To increase the number of water supply reservoirs and to promote their construction, the Department of Energy and Resources Management increased its grants to conservation authorities from 50 to 75 per cent of construction costs. The Department is prepared to make similar grants available to municipalities in areas where conservation authorities have not been established. Where applicable, projects will be brought into agreement with the Government of Canada for cost sharing.

Section 27 of The Ontario Water Resources Commission Act is designed to prevent pollution of the province's water resources. This section of the Act makes it an offence for any municipality or person to discharge or deposit material into a watercourse which may impair its quality.

In cases where it is desired to control algae, aquatic plants, or other water life by the application of chemical pesticides, it is necessary to apply to the Commission for a permit. The reason for this control is to ensure that there will be no unreasonable infringement on the rights of other water users and that the substances used will not be toxic to humans, fish, domestic animals, and wildlife. It also ensures that stable compounds are not used which might accumulate and pose a threat to potable water supplies.

III GROUND WATER

1. Occurrence

The distinction between ground and surface water is simply related to their relative and temporary positions with respect to the land surface. Both are part of a larger circulating system of water called the hydrologic cycle. Ground-water movement involves two interrelated zones termed

the non-saturated and the saturated. The water in the saturated zone is replenished by infiltrating water previously deposited upon the ground surface in the form of rain and snow. As water infiltrates the ground it passes through the unsaturated zone, or zone of aeration, and into the zone of saturation below. In the latter zone, water fills all openings in the earth's formations. The upper surface of this zone is referred to as the water table. The depth to the water table varies from area to area depending on the elevation of the land surface, the permeability of the earth's materials and the amount of precipitation. The water table fluctuates annually and is generally highest in the spring and lowest in the fall. Very little precipitation infiltrates past the zone of aeration during the summer. In fact, during this period, a large amount of ground water is normally lost to evaporation and transpiration.

Under the influence of gravity, ground water moves constantly. The rate of movement is controlled largely by the permeability of the geological formations through which the water passes. Formations consisting of fine-grained materials such as clay, silt, and fine sand generally contain more pore spaces per unit volume and thus more water than formations of coarse sand and gravel. However, because of fine grain size, water will not move through the finer materials as readily as it will through the coarser materials. Bedrock formations such as limestone and shale generally contain few pore spaces due to original fine-grained structure or to the presence of cementing materials between the rock particles. Water is then usually stored in and transmitted through openings termed joints, planes, and fractures. In sandstone flow and storage occur in pore spaces and joints and fractures. Granitic-type rocks generally are not porous and are only able to store and transmit water by means of fractures and joints. Formations capable of yielding and transmitting significant quantities of ground water are called aquifers; formations which are relatively impervious are called aquicludes.

Aquifers are classified as unconfined or confined. An unconfined aquifer is one which is not overlain by a fine-grained formation. The water level in a well penetrating such an aquifer will be the same as the level of the water table. The depth to the water table is variable and dependent largely upon the amount of precipitation, the geology of an area, and the permeability of the earth formations.

Confined aquifers, also known as artesian aquifers, occur where ground water is confined under greater than atmospheric pressure by an overlying fine-grained formation. A well penetrating such an aquifer will have a water level higher than the horizon at which the water is encountered.

In the County of Frontenac ground water occurs in three general types of formations; sand, gravel, and till at the surface, sand and gravel deeper in the overburden, and the bedrock.

Shallow overburden horizons containing ground water under water table conditions are penetrated by many dug wells. In a few scattered locations well points are used. These shallow wells are usually located in depressions between bedrock ridges or adjacent to lakes or streams.

Deeper sand and gravel aquifers are uncommon and usually limited in areal extent. However, such deep overburden deposits are known to exist at Cloyne, Bon Echo, Mountain Grove, and Verona.

The most important source of ground water in the county is the bedrock. In the southern sections most drilled wells terminate in the bedrock, in either the Black River limestone or Potsdam sandstone. In the central and northern sections of the county water supplies are commonly obtained from wells drilled into Precambrian rock.

2. Availability

The availability of ground water ranges from poor to good and is largely controlled by local geologic conditions. Major factors affecting ground water availability include the ability of a formation to transmit ground water and the amount of precipitation which infiltrates into the ground to replenish discharged ground water.

A portion of the annual precipitation of 31-35 inches enters the soil. Much of the precipitation is lost through evaporation and transpiration with the rest replenishing ground-water supplies or flowing overland in streams. The portion that replenishes ground water has not been accurately determined. In overburden having a large proportion of clay, infiltration may be very low. In more sandy or gravelly deposits, infiltration may be high. In areas of limited overburden where the underlying bedrock is highly fractured and sheared, much of the precipitation may reach

the zone of saturation. In areas where the bedrock has few openings there may be virtually no infiltration. Recharge of ground-water reservoirs is greatest during the period from October to April when evapo-transpiration is at a minimum. About 60 per cent of the annual precipitation occurs during this period.

As the depth of overburden is generally shallow, many dug wells are able to penetrate only a short distance into the water table, with the result that supplies from some wells are seriously affected by drought.

The coarser-grained overburden materials such as gravel are considered important possible sources of municipal supplies. Sands, although less permeable, are often capable of yielding good water supplies. Such deposits are present in a number of scattered locations, but generally do not cover large areas. Silt and clay generally yield poor supplies.

Depth of penetration by drilled bedrock wells is variable and dependent on the depth to a water-bearing fracture or joint. As the permeability of the bedrock formation is extremely variable, it is not possible to predict yields for any particular location. Supplies from such wells are generally adequate for domestic needs, and occasionally appear capable of supplying the demands of a small communal system.

3. Water Quality

The following tables show chemical analyses of water samples taken at random from various aquifers within the county. Twenty four samples were taken. They are not necessarily representative of the various aquifers but they illustrate the wide range in quality in the major aquifers. All analyses are listed in ppm except for the pH.

Aquifer	Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chlorides as Cl	pH at Lab.
Precambrian Bedrock	196 to 428	156 to 260	0.13 to 1.90	10 to 88	7.1 to 7.9
Palaeozoic Bedrock	326 to 1070	100 to 310	0.00 to 0.63	8 to 565	7.4 to 7.8
Overburden Sand and Gravel	176 to 606	130 to 502	0.00 to 0.72	7 to 159	7.3 to 7.9

Ground water from all aquifers is generally hard but suitable for most purposes. In general, hardness values are higher in waters from the Palaeozoic formations probably due to the dissolution of carbonates from bedrock. The chloride content in some waters from the Palaeozoic limestone is high, and makes such waters non-potable in several local areas. In some areas, sulphurous water also occurs in the limestone formations. The quality of bedrock aquifers is generally good except in the townships of Howe Island, Kingston, Pittsburgh, and Wolfe Island, where highly mineralized water is often obtained from the limestone aquifer. The iron content in water from the overburden and the Precambrian bedrock is generally in excess of the maximum limit of 0.3 ppm recommended for municipal supplies. Otherwise fresh good quality water can be obtained from these aquifers.

In general, water from the overburden and the Precambrian bedrock aquifers is of better chemical quality with respect to potability than water from the limestone aquifers.

IV SURFACE WATER

1. Water Supply

The City of Kingston and the Township of Kingston operate municipal water systems supplied from the inlet to the St.Lawrence River. A number of industries pump water through private facilities using surface sources. Normal use is made of lakes and streams for livestock watering. Irrigation using surface waters is not common.

2. Waste Water Disposal

The St. Lawrence River receives effluents from municipal sewage treatment plants serving the City of Kingston and the Township of Kingston. The city plant also serves the Barriefield Military Camp. A number of sewage treatment plants serve local subdivisions or institutions and discharge effluent to inland streams. Industrial wastes from a few industrial concerns are discharged after various degrees of treatment to surface streams.

3. Hydrometric Data

While only one streamflow gauging station is located within the county, additional discharge information is available from records of two power generating stations and one streamflow gauging station located outside the county.

The major dams which influence water levels and river flows are summarized in Table 3-1

In 1957 a streamflow gauging station was established on Depot Creek near Bellrock. The discharge at this station, data for which appear in Table 3-2, is subject to regulation at Second Depot Lake for flood control and water supply by the Napanee Valley Conservation Authority.

The discharge of the St.Lawrence River at Kingston is only slightly less than at Cornwall where a streamflow gauging station* has been in operation since 1958. A synopsis of data for this station is presented in Table 3-3A.

The Canadian Hydrographic Service, Department of Mines and Technical Surveys, operates a hydrometric gauge at Kingston to record the water level of Lake Ontario. A synopsis of mean monthly water levels is presented in Table 3-3B.

In Table 3-4 discharge data of the Mississippi River at the High Falls Generating Station are summarized from the records provided by The Hydro-Electric Power Commission of Ontario.

* Moved from Iroquois to Cornwall in 1958. Records at Iroquois date back to 1860.

In Tables 3-5, 3-6, and 3-7 discharge data of the Cataraqui River at Kingston Mills are presented from records provided by the Gananoque Electric Light and Water Supply Company Limited, and lockage data from the Rideau Canal, Canal Division, Department of Transport, Canada.

The Gananoque Electric Light and Water Supply Company Limited, the Mississippi River Improvement Company Limited, and the Rideau Canal maintain a number of gauges on storage lakes within the county.

4. Water Quality

The water quality of the various lakes and rivers is discussed in the subsequent chapters on municipalities. Tables 3-8 to 3-15 inclusive, provide summaries of water quality for the streams throughout the county. The data on chemical quality contained in Tables 3-16 and 3-17 were obtained from the Federal Department of Mines and Technical Surveys. In general, the quality of the surface waters in the county is satisfactory; however, there are confined areas where pollution is evident. These situations are discussed under each municipality.

In recent years there has been an increasing use of herbicides and insecticides. Much of these materials eventually reach the ground and surface waters. To date, use in this province has produced a few isolated problems such as fish kills. However, in order to protect the future quality of our surface streams, it will be necessary for the public to understand and to use these materials carefully.

A problem of general concern is the increasing prevalence of algae and other aquatic growths. When conditions are suitable many types of algae will develop so rapidly that resulting growths may interfere with recreational boating and bathing. In addition, when the algae dies and accumulates on shorelines it produces offensive odours and nuisances. Difficulties with tastes and odours in water supplies and interference with water treatment operations are common experiences.

It is believed that the development of problems with these organisms in water is primarily related to the nutrient enrichment of our surface waters. Wastewater discharging from municipalities and industries and drainage waters laden with nutrient chemicals contribute to this enrichment. Research on the removal of nutrients from sewage treatment plant effluents is being studied by the Commission.

V CONSERVATION AUTHORITIES

Under the Conservation Authorities Act which is administered by the Conservation Authorities Branch, Department of Energy and Resources Management, municipalities within drainage basins may organize as conservation authorities to deal with water conservation and flood control projects. Two authorities, the Napanee Valley and the Moira River, include parts of the County of Frontenac in their respective areas.

1. Napanee Valley Conservation Authority

The Napanee Valley Conservation Authority was established in November, 1947, and has jurisdiction over the entire drainage basin of the Napanee River including 162 square miles in the County of Frontenac. Its purpose is to conserve and improve the watershed of the Napanee River through programmes related to reforestation, flood control, and stream flow stabilization.

The Napanee Valley Conservation Report, 1957, of the Conservation Authorities Branch,* Department of Energy and Resources Management, makes recommendations related to water resources. It recommends that the Authority consider the purchase of potential dam and reservoir sites and proceed with construction as needed.

In 1957 the Authority constructed a dam at the outlet of Second Depot Lake to provide storage and to stabilize flows in the Napanee River through regulated discharge. The dam controls a drainage area of 49.2 square miles and provides a controlled storage capacity of 7,414 acre-feet.

The Authority proposes the construction of a dam on Harwood Creek near Verona. According to an engineering survey, the proposed dam will provide 720 acre-feet of storage, will yield 12 cfs for 30 days and will raise the water level of Verona, Howes, and Hambly Lakes 1.5 feet.

The Authority has initiated preliminary studies of select additional reservoir sites.

* former Conservation Branch, Department of Planning and Development.

2. Moira River Conservation Authority

The Moira River Conservation Authority was established on July 31, 1947, and has jurisdiction over the entire Moira River drainage basin including 14 square miles in the county.

The Moira Valley Conservation Report, 1950, makes recommendations related to conservation of land and water resources. Its programmes include flood control and streamflow regulation projects. None of the proposed works would lie within Frontenac.

VI HYDRO POWER DEVELOPMENT

In the past, many streams were utilized to develop power for the operation of feed and saw mills. Most of these works have now been abandoned because of changing economic patterns. Major power development operators active in the county are the Mississippi River Improvement Company Limited, and the Gananoque Electric Light and Water Supply Company Limited.

Table 3-1 lists all the major dams in and beyond the county boundaries which affect local water levels.

1. Mississippi River Improvement Company Limited

In the northern part of the county a number of storage lakes within the Mississippi River watershed are operated by the company. Water is provided to the Hydro-Electric Power Commission of Ontario for production of hydro-electric power at the High Falls Generating Station to the east.

2. The Gananoque Electric Light and Water Supply Company Limited

The Gananoque Electric Light and Water Supply Company Limited operates a number of small hydro-electric generating stations along the southern section of the Rideau Canal. These are located in series and those within the County of Frontenac are located at Brewers Mills, Washburn, and Kingston Mills. Under the terms of lease with the Dominion Government, the company is allowed the use of all water surplus to navigational requirements on the Rideau Canal. The power company operates a number of storage lakes which have controlled discharges into the Rideau Canal system.

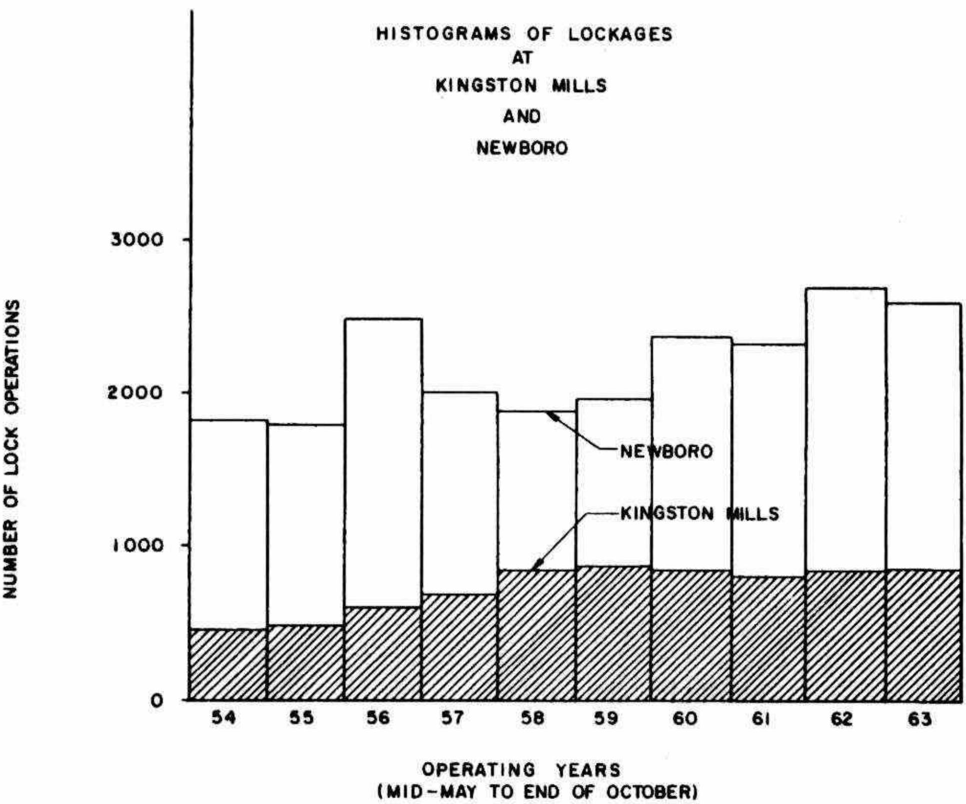
VII NAVIGATIONAL SYSTEMS

Two canal systems of importance to the county, the St. Lawrence Seaway and the Rideau Canal, had beginnings in the early history of Canada.

1. Rideau Canal

The Rideau Canal was initiated as a military supply route to connect Ottawa and Kingston. By means of short cuttings, dams, and locks at appropriate locations, the canal has made the Rideau and Cataraqui Rivers navigable. The canal utilizes the chains of scenic lakes on these river systems and certain headwaters of the Gananoque River to form one connected waterway from the Ottawa River to Lake Ontario at Kingston. The canal system is operated by the Canal Division, Department of Transport, Canada.

Extensive use is made of the canal for tourism and recreation. The histograms of lockages at Kingston Mills and Newboro indicate the increasing trend of use. The histogram for the period 1954 to 1963 is indicated following.



Some appreciation of works within and beyond the county is necessary to understand the regulation of water associated with the canal system. The connection between Upper Rideau Lake of the Rideau River system and Newboro Lake of the Gananoque River system was made by a lock at Newboro. Water sufficient only to operate this lock is diverted from the Rideau River system to the Gananoque River system. Dams at the outlets of Wolfe and Bobs Lakes are operated to supply water for navigational purposes to Upper Rideau Lake and Rideau Lake respectively.

The connection between the Gananoque River system and Cataraqui River system is at Cranberry Lake where the divide had been poorly defined in a marsh. The low land has been flooded due to the construction of control dams at both Morton and Brewers Mills. The water contained between these control dams is normally allowed to drain into the Cataraqui River via the control works at the Brewers Mills dam.

In the Gananoque section above Morton dam, water supply is also regulated for power purposes by means of dams controlling the discharges from the Devil Lake system, Buck Lake, and Loughborough Lake. The water available for power purposes is the extra discharge provided by means of controlled storage under the jurisdiction of the Gananoque Electric Light and Water Supply Company Limited in addition to navigational surpluses on the Rideau Canal.

Only seven of the forty-nine locks of the Rideau Canal are located within the county. All are in the Cataraqui River section. Proceeding downstream there are a flight of two locks at Brewers Mills, a single lock at Washburn and four locks at Kingston Mills. The water level of the canal system below Kingston Mills is that of Lake Ontario.

Weirs or by-washes are provided at each of the lockage sites for control of water levels. Hydro-electric generating plants are located near each of these sites and utilize the water discharged through the weirs.

2. St. Lawrence Seaway

The St. Lawrence Seaway, completed in 1959, was constructed as a joint project by the United States, Canada, and the bordering states and provinces. Through its system of locks and canals it allows all but the larger ocean vessels to enter the Great Lakes. In addition, hydro-electric power is generated at Cornwall. Water levels in this system are controlled by works located at Cornwall and Iroquois.

In regard to shipping, the seaway has exerted only a limited effect on the County of Frontenac. Access to this route is available through the docking facilities in the City of Kingston.

VIII CONCLUSIONS

Extensive use is made of the surface water resources of the county for municipal and industrial water supply, navigation, power, and recreational purposes. Important conservation measures have been installed and are being planned.

For the urban part of the county surface water is and will continue to be the main source of supply for municipal and industrial needs. In the remainder of the county wells provide a satisfactory source of water supply for private and small communal systems. Quality problems due to highly mineralized water are present in the supplies from wells located in parts of the townships of Kingston, Pittsburgh, Howe Island, and Wolfe Island.

The sanitary quality of surface waters is generally satisfactory although local areas of pollution exist. In all known areas of pollution investigations and negotiations for abatement are continuing, or corrective measures are being undertaken.

There have been no recorded fish kills or other adverse conditions caused by the misuse of pesticides. However, experience in other areas indicates that this is a matter which will require increasing awareness and careful use by the public. The Commission employs a permit system to regulate the use of aquatic pesticides.

TABLE 3-1

MAJOR DAMS AFFECTING WATER LEVELS IN THE COUNTY OF FRONTENAC

Drainage Basin	Stream or Lake Regulated	Location of Dam	Operator	Purpose
Mississippi River	Palmerston Lake	Outlet of lake	Dept. of Land & Forests	To maintain accustomed water level at old mill site.
	Shabomeka Lake	Outlet of lake	Mississippi River Improvement Company Limited	To create six storage reservoirs for the regulated release of water for power developments on the Mississippi River.
	Mazinaw Lake	Outlet of lake		
	Kashwakamak Lake	Outlet of lake		
	Mississagagon Lake	Outlet of lake		
	Clarendon Lake	Outlet of lake		
	Cross Lake	Outlet of lake		
	Malcolm Lake	South of Ardock		Former sawmill
	White Lake	on White Lake Creek	Dept. of Lands & Forests	To supply water to fish hatchery
Salmon River	Big Clear Lake	on Big Clear Lake Creek east of Arden	Mr. Cecil Barker	Former mill
Napanee River	Second Depot Lake	Outlet of lake	Napanee Valley Conservation Authority	To stabilize streamflow
	Fourteen Island Lake	Outlet of Lake	Napanee River Improvement Co.	To augment low flows for water supply.

TABLE 3-1 (CONT'D)

MAJOR DAMS AFFECTING WATER LEVELS IN THE COUNTY OF FRONTENAC

Drainage Basin	Stream or Lake Regulated	Location of Dam	Operator	Purpose
Rideau River	Bobs Lake Wolfe Lake	Outlet of lake Outlet of lake	Rideau Canal Authority	To regulate water levels of Rideau Canal system in Rideau lakes and river.
Cataraqui River	Canoe and Eel Lakes Knowlton, Otter, Holleford, Desert, Birch, and Kingsford Lakes	Outlet of Canoe Lake Outlet of Kingsford Lake	The Gananoque Electric Light and Water Supply Company Limited	To create storage reservoirs for regulated release of water for hydro-electric power stations at Jones Falls, Brewers Mills, Washburn and Kingston Mills.
	Buck Lake	Mississagua Creek (near outlet Buck Lake)	" "	
	Loughborough Lake	North outlet on Hart Creek at Battersea	" "	
	Whitefish and Cranberry Lakes	(1) at Morton	Rideau Canal Authority	To regulate the diversions of flow from headwater lakes of Gananoque River into Cataraqui River. Both dams.
		(2) Brewers Mills	Rideau Canal Authority	To increase water level in lakes for navigation.

TABLE 3-1 (CONT'D)

MAJOR DAMS AFFECTING WATER LEVELS IN THE COUNTY OF FRONTENAC

Drainage Basin	Stream or Lake Regulated	Location of Dam	Operator	Purpose
Cataraqui River (Cont'd)	Cataraqui River	Washburn and Kingston Mills	Rideau Canal Authority	To increase water levels in Cataraqui River for navigation.
Millhaven Creek	Gould Lake Sydenham Lake	Outlet of lake Outlet of lake	Mr. Frank Anglin	To store water for mill operations

TABLE 3-2

DISCHARGE DATA OF DEPOT CREEK

FROM STREAMFLOW GAUGING STATION NO. $2HM_2$ NEAR BELLROCK

Water Year Ending(a)	Max. Day cfs	Avg. Day cfs	Avg. Summer Day(b) cfs	Min. Month cfs	Min. Summer Month cfs	Min. 7-Day cfs	Min. Day cfs
1963 c	363	52	27.7	12.1	17.2	8	6.9
1962	428	48	20.7	14.7	14.7	11.3	9.6
1961	305	43	34.5	7.5	19.4	5	2.8
1960	642	91	23.2	19.2	19.2	15.7	13.8
1959	748	61	23.7	0.5	0.5	0	0
1958	324	63	38.3	0	28	0	0
1957	299		16.8		4.3		0

Drainage Area: 67 square miles

Period of Record: January 1957 to date

Extremes Recorded:

Daily Maximum 9 April 1959 - 748 cfs
Daily Minimum at various times - 0 cfs

(a) Water Year - A twelve month period from October 1 to September 30th incl.

(b) Summer - Defined as four-month period June, July, August, and September.

(c) Provisional Records

Table compiled from data supplied by Water Resources Branch, Department of Northern Affairs and National Resources.

NOTE: Discharge affected by regulation at Second Depot Lake Dam.

TABLE 3-3A

SYNOPSIS OF DISCHARGE DATA OF ST. LAWRENCE RIVER

FROM STREAMFLOW GAUGING STATION NO. $2MC_2$ AT CORNWALL

Drainage Area:	296,000 square miles	
Period of Record:	July 1958 to date (Records prior to 1958 were obtained at Iroquois Station No. 2MB5 from 1860)	
Extremes Recorded:		
Daily Maximum	24, 26, 28 June 1960	295,000 cfs
Daily Minimum	9 January 1959	154,000 cfs

Remark: Subject to regulation

FROM STREAMFLOW GAUGING STATION NO. $2MB_5$ AT IROQUOIS

Drainage Area:	298,160 square miles	
Period of Record:	1860 to July 1958	
Average Discharge:	(98 years)	240,700 cfs
Extremes Recorded:		
Daily Maximum	2 July 1958	324,000 cfs
Daily Minimum	7 February 1936	139,000 cfs

Data from Water Resources Papers No. 126 (Station at Iroquois) and No. 137 (Station at Cornwall), Water Resources Branch, Department of Northern Affairs and National Resources.

TABLE 3-3B

SYNOPSIS OF MEAN MONTHLY WATER LEVELS

OF LAKE ONTARIO AT KINGSTON

Month	1963	1964	Last 10 Years	Since 1860
January	243.92	242.88	243.83	244.19
February	243.39	242.35	243.68	244.24
March	243.27	242.35	243.93	244.50
April	244.43	243.13	244.72	245.11
May	245.31	244.03	245.31	245.52
June	245.72	244.45	245.47	245.67
July	245.63	244.48	245.27	245.59
August	245.45	244.13	244.88	245.27
September	244.81	243.67	244.45	244.86
October	244.13	----	244.25	244.51
November	243.61	----	244.06	244.27
December	243.34	----	243.94	244.20

Extremes Recorded:

Maximum Water Level	248.07	June 1952
Minimum Water Level	241.50	December 1934

Elevations are in feet referred to the International Great Lakes Datum (1955).
The reference zero for IGLD (1955) is the mean water level computed as 12.444 feet below benchmark 1248-G or 7.486 feet above the zero of the Canadian Hydrographic Service gauge at Father Point, Quebec.

Table compiled from Water Level Bulletins, Inland Water Levels, Canadian Hydrographic Service, Department of Mines and Technical Surveys.

TABLE 3-4

DISCHARGE DATA OF MISSISSIPPI RIVER

FROM OPERATIONAL RECORDS OF HIGH FALLS GENERATING STATION

Water Year Ending(a)	Max. Day cfs	Avg. Day(c) cfs	Avg. Summer Day(b,c) cfs	Min. Month cfs	Min. Summer Month cfs	Min. 7-Day cfs	Min. Day cfs
1963	956	268	199	131	147	107	86
1962	640	213	267	105	105	80	0
1961	656	221	258	158	190	141	0
1960	1954	484	210	165	182	144	0
1959	1041	337	207	150	150	103	0
1958	734	341	248	197	215	163	0
1957	765	333	215	207	207	68	0
1956	1750	530	336	162	162	155	148
1955	1738	538	273	187	187	127	0

(a) Water Year - A twelve month period from October 1 to September 30th incl.

(b) Summer - Defined as four-month period June, July, August, and September.

(c) - Calculated from the sum of the mean daily discharge for the months concerned divided by the number of months.

Table compiled from mean daily discharge data of the Mississippi River at High Falls Generating Station as supplied by The Hydro-Electric Power Commission of Ontario.

NOTE: Discharge affected by regulation.

TABLE 3-5

CATARAQUI RIVER AT KINGSTON MILLS GENERATING STATION

MONTHLY FLOW - C.F.S.

1954 - 1964

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1954	230	364	290	232	238	156	115	33	139	274	278	269
1955	274	342	480	324	310	356	255	278	292	222	268	290
1956	268	226	296	258	272	200	102	127	83	154	174	154
1957	114	156	338	296	74	23	58	44	89	81	77	238
1958	380	326	420	147	156	87	72	65	143	225	285	302
1959	356	352	450	398	210	81	118	132	104	179	124	352
1960	420	415	460	378	376	66	37	41	38	48	150	162
1961	140	107	242	167	320	290	235	113	118	24	87	246
1962	286	260	386	423	175	45	46	65	62	132	170	214
1963	274	212	415	170	305	106	51	72	124	137	139	254
1964	342	418	258	303	160	62	6					
Average	280	289	367	281	236	134	100	97	109	148	175	248

TABLE 3-6

KINGSTON MILLS GENERATING STATION

BY-PASS DUE TO EXCESSIVE FLOWS

1959 - 1964

1959	-	April	-	14	Days
1960	-	March	-	18	Days
	-	April	-	28	Days
	-	May	-	11	Days
1961	-	May	-	3	Days
1962	-	April	-	8	Days
1963	-	March	-	3	Days

TABLE 3-7

RIDEAU CANAL LOCK OPERATIONS*

	Newboro Lock Station	Kingston Mills Lock Station
1964	2097 (End of Aug.)	775 (End of Aug.)
1963	2583	858
1962	2691	859
1961	2322	826
1960	2383	868
1959	1970	899
1958	1876	858
1957	2016	686
1956	2489	611
1955	1808	482
1954	1835	473

* Number of times locks opened and closed. Lockages occur during the period from mid May to the end of October. One up-bound lockage takes 180,000 cubic feet of water (1.12 million gallons) and one down-bound lockage takes 100,000 cubic feet of water (0.62 million gallons). Lockages are approximately 50 per cent up-bound and 50 per cent down-bound.

TABLE 3-8

STREAM SAMPLE RESULTS-LAKE ONTARIO, ST. LAWRENCE RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
LO 264.4	Frontenac, Lennox & Addington Counties boundary	Aug /62							2
		July/63							48
		July/64	1.3	198	1		8.4	26	2
LO 266.2	Lemoine Point, Airport W.W. at shore	July/62							6
		July/64							14
		July/64							138
		July/64							0
		July/64							88
		July/64							1
SL 145.8-I	Point Pleasant W.W. intake	July/64							36
		July/64							0
		July/64							2
		July/64							0
SL 145.8	Point Pleasant W.W. at shore	July/64							0
		July/64							34
		July/64							9
SL 144.8	DuPont bathing beach	July/64							70

TABLE 3-8 (Cont'd)

STREAM SAMPLE RESULTS-LAKE ONTARIO, ST. LAWRENCE RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
SL 144.6	DuPont W.W.	Aug /62							8
		July/63							8
		July/64							24
SL 144.1	Opposite mouth of Cataraqui Cr.	Aug /62							60
		July/63							10
SL 143.5	Lake Ontario Park	Aug /62							2
		July/63							26
		July/64							18
SL 142	City of Kingston W.W.	Aug /62							12
		July/63							6200
		July/64							900
SL 141.8	MacDonald Park	Aug /62							1700
		July/64							16
SL 141.2	East end of Kingston opposite City Hall	Aug /62							6
		July/63	1.9	222		5			1900
		July/64	0.8	218	2				0

TABLE 3-8 (Cont'd)

STREAM SAMPLE RESULTS-LAKE ONTARIO, ST. LAWRENCE RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
SL 139.4	Point Frederick	Aug /62							50
		July/63	1.4	214		1.8			96
		July/64							14
SLWI 139	Wolfe Island, Cone Point	July/64	0.7	228	6				0
SL 138.8	Army bathing beach	July/64							370
SL 138.5	Cartwright Point	Aug /62							800
		July/64							8
SL 137.2	Kingston S.T.P. at dock upstream of effluent	Aug /62							14
		July/63							50
		June/64							78
		July/64							37
		Oct /64	2.0	218	20		7.6	26	70
SL 136.7	McNight property	Aug /62							12
		July/63							37
		July/64							41

TABLE 3-8 (Cont'd)

STREAM SAMPLE RESULTS-LAKE ONTARIO, ST. LAWRENCE RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
SL 136.3	Glen Lawrence W.W. at shore	Aug /62							128
		July/63							124
		June/64							9,600
		June/64							9,700
		July/64							11,000
		Oct /64	1.8	206	3		8.5	26	71,000
SL 136.1	Glen Lawrence Manor	Aug /62							1,300
		July/64							1,900
SL 134.2	Treasure Island	July/64							10
		Oct /64	1.4	200	1		8.6	27	850
SL 131.6	Howe Island west end ferry	Aug /64							2
		July/64							0
SL 123.3	Howe Island east end ferry	Aug /62							600
		July/63	1.2			0.7			12
		July/64	0.9	202	1				74

TABLE 3-9

STREAM SAMPLE RESULTS-CATARAQUI RIVER (RIDEAU WATERWAY)

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab
C 0.7-W	La Salle Causeway, west side	July/64	1.3	226	3		8.3
C 0.7-C	La Salle Causeway, centre	Aug /62					
		Aug /63	1.4				
		July/64	0.9	214	3		8.4
C 0.7-E	La Salle Causeway, east side	July/64	1.0	220	2		8.3
C 1.3	Main channel ¼ mile south of Bell Island	July/64	2.6	238	9		7.8
C 1.7	West of Bell Island	July/64	23	432	26		7.6
C 1.7-B	200 ft. east of mouth of creek which receives Davis Tannery waste	June/64	84			100	7.6
		June/64	540			200	8.5
		July/64	37	1,874	1,014		7.6
C 1.8	Main channel east of Bell Island	June/64	1.2			6.5	8.2
		July/64	1.2	128	13		8.7

TABLE 3-9 (Cont'd)

STREAM SAMPLE RESULTS-CATARAQUI RIVER (RIDEAU WATERWAY)

Mileage Point	Sampling Point Description	Date	Apparent Colour Units	Chrome as Cr (ppm)	Chloride as Cl (ppm)	Phenols (ppb)	M.F. Coliforms per 100 ml
C 0.7-W	La Salle Causeway, west side	July/64		0.0	26	10	48
C 0.7-C	La Salle Causeway, centre	Aug /62					1,070
		Aug /63				7	
		July/64		0.0	24	0	12
C 0.7-E	La Salle Causeway, east side	July/64		0.0	26	0	16
C 1.3	Main channel ¼ mile south of Bell Island	July/64	20	0.4	34		390
C 1.7	West of Bell Island	July/64	25	0.5	78		2,300
C 1.7-B	200 ft. east of mouth of creek which receives Davis Tannery wastes	June/64	75	2.1		40	130,000
		June/64		22.5			1,080,000
		July/64	60	16.0	77		11,000
C 1.8	Main channel east of Bell Island	June/64	5	0.0		6	202
		July/64	15	0.0	11		4

TABLE 3-9 (Cont'd)

STREAM SAMPLE RESULTS-CATARAQUI RIVER (RIDEAU WATERWAY)

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab
C 4.7	At Hwy #401	Aug /62	2.0	124			
		Aug /63					
		July/64					
C 5.1	500 ft. downstream from Josh's Marina	July/64					
C 5.2	Josh's Marina bathing area	July/64					
C 11.6	Joyceville Institution W.W.	July/64					
C 16.0	Brewers Mills	Aug /62					
		Aug /63					
		July/64					
C 33.6	Chaffeys Locks	Aug /62					
		Aug /63					
		July/64	1.0	126	2		

TABLE 3-9 (Cont'd)

STREAM SAMPLE RESULTS-CATARAQUI RIVER (RIDEAU WATERWAY)

Mileage Point	Sampling Point Description	Date	Apparent Colour Units	Chrome as Cr (ppm)	Chloride as Cl (ppm)	Phenols (ppb)	M.F. Coliforms per 100 ml
C 4.7	At Hwy #401	Aug /62				2	50
		Aug /63					18
		July/64					900
C 5.1	500 ft. downstream from Josh's Marina	July/64					18
C 5.2	Josh's Marina bathing area	July/64					180
C 11.6	Joyceville Institution W.W.	July/64					80
C 16.0	Brewers Mills	Aug /62					30
		Aug /63					110
		July/64					30
C 33.6	Chaffeys Locks	Aug /62					86
		Aug /63					130
		July/64					19

TABLE 3-10

STREAM SAMPLE RESULTS-CATARAQUI CREEK

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	pH at Lab	Chloride as Cl	Phenols (ppb)	Ether Solubles (ppm)	M.F. Coliforms per 100 ml
CC 0.0	Mouth at Lake Ontario	Aug /62								50
		Sept/63								0
		July/64	3.2	264	13	8.2	30	4	2	broken
CC 2.3	Hwy #2	Aug /62	1020	660	238			3	250	320,000
		Sept/63	92	348	11				12	250
		July/64	>390	1176	486	8.1	34	50	7500	broken
CC 2.8	Counter St. east of Cataraqui Village	July/64	1.4	312	12	7.9	26	8	4	270

TABLE 3-11

STREAM SAMPLE RESULTS-NAPANEE RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
N 24.6	Below Petworth	July/64	0.5	82	1	8.2	5	14
NCH 31.6	Hwy #38 south of Verona	July/64						9
NCD 32.6	Bridge south of Bellrock	July/64						82
NCHX 33.6	Verona Lake at creek from Howes Lake east of Hwy #38	July/64	1.3	154	1	8.6	7	93

TABLE 3-12

STREAM SAMPLE RESULTS-COLLINS CREEK

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
CO 0.1	Hwy #33	Aug /62						8
		Sept/63						30
		July/64	0.7	212	2	8.6	26	8
CO 1.8	Woodbine Rd.	Aug /62	1.3	362				100
		Sept/63	1.1	342	5			1,290
		July/64						50
CO 2.6	Hwy #2	Aug /62						120
		Sept/63						380
		July/64	1.5	340	2	8.0	13	122

TABLE 3-13

STREAM SAMPLE RESULTS-MILLHAVEN CREEK

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
M 15.8	Murvale	July/64	1.3	164	1			2
M 20.8	Sydenham-Harrowsmith	Aug /62						12,700
	Rd.	Sept/63	1.8	148	2			470
		July/64						2,400
M 21.4	Outlet of Sydenham	Aug /62						52
	Lake at Sydenham	Sept/63	2.5	136	2			0
	Village Park	July/64	1.0	152	9	8.6	6	22

TABLE 3-14

STREAM SAMPLE RESULTS-MISSISSIPPI RIVER

Mileage Point	Sampling Point Description	Date	5-Day BOD (ppm)	Solids (ppm) Total	Solids (ppm) Susp.	Turbidity Units	pH at Lab	Chloride as Cl	M.F. Coliforms per 100 ml
M 70.8	Snow Rd. Station	July/64	1.3	87	1				63

TABLE 3-15

STREAM SAMPLE RESULTS - INLAND LAKES

Sample Number	Sampling Point Description	Date	M.F.Coliforms per 100 ml
D-L-1	Devil Lake at road on east shoreline Twp. of Bedford	July/64	226
Bu-L-1	Buck Lake at narrows between North Bay & South Bay at County Rd. Twp. of Bedford	July/64	3,900
L-L-1	Loughboro Lake at Kepler bathing area Twp. of Kingston	July/64	4,200
L-L-2	Loughboro Lake near Loughboro Inn Twp. of Storrington	July/64	3,700
B-L-1	Bobs Lake Twp. of Bedford	July/64	90
LO-L-1	Long Lake Twp. of Olden	July/64	36
S-L-1	Sharbot Lake at Hwy 38 Twp. of Oso	July/64	18
Si-L-1	Silver Lake, Provincial Park beach Twp. of Oso	July/64	3,200
Cl-L-1	Clarendon Lake Coxdale Twp. of Clarendon	July/64	66

TABLE 3-15 (Cont'd)

STREAM SAMPLE RESULTS-INLAND LAKES

Sample Number	Sampling Point Description	Date	M.F. Coliforms per 100 ml
M-L-1	Mazinaw Lake, Bon Echo Provincial Park beach, Twp. of Barrie	July/64	710
C-L-1	Collins Lake, outlet at north end, Twp. of Storrington	July/64	164
Sy-L-1	Sydenham Lake at Sydenham Park beach, Twp. of Loughboro	July/64	162

TABLE 3-16A

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN ST. LAWRENCE RIVER-GREAT LAKES DRAINAGE BASIN
(in parts per million)

Date of Collection	Sample Number	Storage Period (days)	Stream Discharge (second -feet) Sampling Date	Stream Discharge (second -feet) Monthly Mean	Water Temperature (°F)	Dissolved Oxygen	Carbon Dioxide	pH	Colour	Turbidity
STATION NO. 10: LAKE ONTARIO AT PLANT INTAKE, KINGSTON, ONTARIO										
Feb 21/47	1372	4					1.9	8.1	0	1
July /48	2147	15						8.0	8	
STATION NO. 45: NAPANEE RIVER AT NAPANEE, ONTARIO										
Mar 6/47	1383	7	240	520				7.5	80	2
Dec 15/49	3684	19	51	148	59			8.0	10	4
STATION NO. 46: SALMON RIVER AT SHANNONVILLE, ONTARIO										
March 20/50	4126	30			33			7.8	30	4
STATION NO. 49: MOIRA RIVER NEAR BELLEVILLE, ONTARIO - Length of river - 60 miles										
June 11/48	2548	173	934	955	65	(9.6)	(2.0)	8.3 (7.7)	50 (85)	0 (<7)

TABLE 3-16B

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN ST. LAWRENCE RIVER-GREAT LAKES DRAINAGE BASIN
(in parts per million)

Date of Collection	Sample Number	Suspended Matter: Dried at 105°C	Suspended Matter: Ignited at 550°C	Specific Conductance Micromhos (K x 10^6) at 25°C	Residue on Evaporation at 105°C (Dissolved Solids): P.P.M.	Residue on Evaporation: Tons/acre-foot	Residue on Evaporation: Thousand tons/day	Loss on Ignition at 550°C	Calcium (Ca)	Magnesium (Mg)
STATION NO. 10: LAKE ONTARIO AT PLANT INTAKE, KINGSTON, ONTARIO										
Feb 21/47	1372				179	.243			42.9	12.0
July /48	2147			295	188	.256		17.0	39.8	8.9
STATION NO. 45: NAPANEE RIVER AT NAPANEE, ONTARIO										
March 6/47	1383				196	.266	.127		47.2	10.5
Dec 15/49	3684	1.2	0.6	327	213	.289	.029	17.6	56.6	6.3
STATION NO. 46: SALMON RIVER AT SHANNONVILLE, ONTARIO										
March 20/50	4126			258					44.0	5.3
STATION NO. 49: MOIRA RIVER NEAR BELLEVILLE, ONTARIO - Length of river - 60 miles										
June 11/48	2548			195	133	.181	.335	22.4	32.8	3.0

TABLE 3-16C

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN ST. LAWRENCE RIVER-GREAT LAKES DRAINAGE BASIN
(in parts per million)

Date of Collection	Sample Number	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Iron (Fe): Total	Iron (Fe): Dissolved	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Bicarbonate (HCO_3)	Carbonate (CO_3)
STATION NO. 10: LAKE ONTARIO AT PLANT INTAKE, KINGSTON, ONTARIO											
Feb 21/47	1372	7.6 as Na			.05	25.1	19.1	.9		117	0
July /48	2147	10.1	1.4		0	47.9	18.9	7.9		120	4.8
STATION NO. 45: NAPANEE RIVER AT NAPANEE, ONTARIO											
March 6/47	1383	8.1 as Na			.09	32.1	4.2	3.1		139	0
Dec 15/49	3684	3.9	1.6	.14	.02	32.5	4.0	7.1	.10	153	2.4
STATION NO. 46: SALMON RIVER AT SHANNONVILLE, ONTARIO											
March 20/50	4126	2.2	1.0			37.7	0			122	0
STATION NO. 49: MOIRA RIVER NEAR BELLEVILLE, ONTARIO - Length of river - 60 miles											
June 11/48	2548	2.3	1.7	.13		13.2	0	.6		112 (105)	0 (0)

TABLE 3-16D

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN ST. LAWRENCE RIVER-GREAT LAKES DRAINAGE BASIN
(in parts per million)

Date of Collection	Sample Number	Silica (SiO_2) Gravi-metric	Silica (SiO_2) Colori-metric	Hardness as $CaCO_3$ Non-car-bonate	Hardness as $CaCO_3$ Total	Sum of Constituents	Per Cent Sodium	Saturation Index +	Saturation Index −
STATION NO. 10: LAKE ONTARIO AT PLANT INTAKE, KINGSTON, ONTARIO									
Feb 21/47	1372	5.0		60.6	156	170		0.3	
July /48	2147	2.0	1.4	37.8	136	200	13.7	0.2	
STATION NO. 45: NAPANEE RIVER AT NAPANEE, ONTARIO									
March 6/47	1383	6.0		47.7	161	180			0.2
Dec 15/49	3684	4.6	4.6	37.5	167	194	4.8	0.4	
STATION NO. 46: SALMON RIVER AT SHANNONVILLE, ONTARIO									
March 20/50	4126		5.2	31.5	132	155	3.6	0	
STATION NO. 49: MOIRA RIVER NEAR BELLEVILLE, ONTARIO - Length of river - 60 miles									
June 11/48	2548	3.0	4.2	2.2	94.2	113	4.9	0.2	

TABLE 3-17A

CHEMICAL ANALYSIS OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Storage Period (days)	Stream Discharge (second -feet) Sampling Date	Monthly Mean	Water Temperature (°F)	Dissolved Oxygen	Carbon Dioxide	pH	Colour	Turbidity
STATION NO. 80: MADAWASKA RIVER ABOVE ARNPRIOR - DRAINAGE AREA 3,185 SQUARE MILES										
May 9/47	1458	5	16,550	12,190				7.4	45	1.0
June 12/47	1504	4	8,090	7,220				7.4	40	0.7
July 7/47	1590	22	1,490	3,250				7.4	40	8.5
Aug 9/47	1624	16	2,110	1,520				7.3	45	1.4
Sept 13/47	1664	23	985	1,490				7.5	35	2.6
Oct 18/47	1706	23	1,170	1,690				7.4	35	1.7
Nov 8/47	1734	18	1,180	1,960				7.4	35	2.5
Dec 5/47	1779	42	2,110	2,110				7.5	30	1.0
Jan 2/48	1799	34	2,150	2,150				7.5	35	6.6
Feb 6/48	1823	17	2,240	2,240				7.3	35	5.1
March 6/48	1873	12	2,700	2,700				7.1	35	5.1
April 10/48	1937	11	7,650	7,270				7.3	45	1.5
Average (12 samples)		19.1		3,816				7.4	37.9	3.1
STATION NO. 72: RIDEAU RIVER AT INTAKE TO WATER WORKS, SMITHS FALLS, ONTARIO										
March 7/47	1384	6						7.5	30	0.9
April to August		N O S A M P L E S T A K E N								
Sept 26/47	2025	252			51.4	(9.7)	(2.5)	8.3	40	---
								(7.9)	(30)	(<7)

TABLE 3-17A (Cont'd)

CHEMICAL ANALYSIS OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Storage Period (days)	Stream Discharge (second -feet) Sampling Date	Monthly Mean	Water Temperature (°F)	Dissolved Oxygen	Carbon Dioxide	pH	Colour	Turbidity
STATION NO. 73: TAY RIVER AT PERTH, ONTARIO										
Sept 25/47	2107	316			57.6	9.6	2.0	8.2	30	---
								(7.9)	(45)	(<7)
STATION NO. 76: MISSISSIPPI RIVER NEAR APPLETON, ONTARIO - DRAINAGE AREA 1,150 SQUARE MILES										
May 6/47	1446	4	5,320	3,910				7.8	40	2.5
STATION NO. 77: MISSISSIPPI RIVER AT CARLETON PLACE, ONTARIO										
March 7/47	1385	6	1,340	1,890				7.5	40	0.7
STATION NO. 78: SHARBOT LAKE NEAR SHARBOT LAKE, ONTARIO										
Sept 25/47	2092	279	410	394	59.0	(9.4)	(2.5)	7.0	12	
								(7.9)	(40)	(<7)
STATION NO. 79: MADAWASKA RIVER AT WATER WORKS, ARNPRIOR, ONTARIO										
Sept 15/47	2036	269	1,380	1,490	73.0	(7.4)	(6.0)	8.0	32	
								(7.9)	(65)	(10.0)

TABLE 3-17B

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Specific Conductance Micromhos ($K \times 10^6$) at 25°C	Residue on Evaporation (Dissolved Solids) P.P.M.	Tons/acre-foot	Thousand tons / day	Loss on Ignition at 550°C	Calcium (ca)	Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)
May 9/47	1458	---	72.5	0.099	3,250	---	12.6	2.7	9.7	
June 12/47	1504	---	72.6	0.099	1,590	---	14.1	2.8	1.3	
July 7/47	1590	---	84.2	0.115	340	32.6	15.2	3.3	4.5	
Aug 6/47	1624	---	77.6	0.105	440	34.2	15.9	3.3	2.5	
Sept 13/47	1664	110.43	80.6	0.110	215	18.6	16.8	3.1	4.4	
Oct 18/47	1706	90.64	70.2	0.095	220	18.6	13.5	4.8	0.7	
Nov 8/47	1734	83.05	65.2	0.089	208	18.6	11.0	2.7	3.2	
Dec 5/47	1779	77.22	63.6	0.087	364	18.2	10.5	2.8	3.9	
Jan 2/48	1799	76.01	70.0	0.095	405	22.4	10.4	4.3	1.4	
Feb 6/48	1823	71.39	61.8	0.084	373	23.2	9.0	2.7	2.0	1.0
March 6/48	1873	64.90	55.8	0.076	407	22.0	8.0	2.8	3.0	0.5
April 10/48	1937	106.37	83.0	0.113	1,714	32.2	20.5	3.3	1.5	0.5
Average (12 samples)		83.75	71.4	0.098	794	24.1	13.3	3.2	3.3	

STATION NO. 72: RIDEAU RIVER AT INTAKE TO WATER WORKS, SMITHS FALLS, ONTARIO

Date of Collection	Sample Number	Specific Conductance	P.P.M.	Tons/acre-foot	Thousand tons / day	Loss on Ignition	Calcium	Magnesium	Sodium	Potassium
March 7/47	1384		151.5	0.206			32.9	7.2	5.0	
April to August		N O S A M P L E S T A K E N								
Sept 26/47	2025	179.41	110.6	0.150		46.2	26.4	7.3		

TABLE 3-17B (Cont'd)

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Specific Conductance Micromhos (K x 10^6) at 25°C	Residue on Evaporation (Dissolved Solids) P.P.M.	Tons/acre-foot	Thousand tons/day	Loss on Ignition at 550°C	Calcium (ca)	Magnesium (Mg)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)
STATION NO. 73: TAY RIVER AT PERTH, ONTARIO										
Sept 25/47	2107	156.86	103.6	0.141		17.0	22.0	5.3	4.9*	
STATION NO. 76: MISSISSIPPI RIVER NEAR APPLETON, ONTARIO - DRAINAGE AREA 1,150 SQUARE MILES										
May 6/47	1446		106.0	0.144	1,521		21.4	6.6	8.1	
STATION NO. 77: MISSISSIPPI RIVER AT CARLETON PLACE, ONTARIO										
March 7/47	1385		148.0	0.201	534		35.0	7.0	5.6	
STATION NO. 78: SHARBOT LAKE NEAR SHARBOT LAKE, ONTARIO										
Sept 25/47	2092	207.57	131.6	0.179	146	24.4	30.4	7.2	0.6*	
STATION NO. 79: MADAWASKA RIVER AT WATER WORKS, ARNPRIOR, ONTARIO										
Sept 15/47	2036	119.68	85.6	0.116	318	22.4	16.8	3.2	2.6*	

* Alkalis calculated as Na

TABLE 3-17C

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Iron as Fe Total	Nitrite (NO_2)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Phosphate (PO_4)	Bio-Carbonate (BCO_3)	Carbonate (CO_3)
STATION NO. 80: MADAWASKA RIVER ABOVE ARNPRIOR - DRAINAGE AREA 3,185 SQUARE MILES									
May 9/47	1458	0.05	0	15.6	0	2.7		38.8	0
June 12/47	1504	0	0	9.9	0	3.1		46.8	0
July 7/47	1590	0.23	0	9.4	0	2.7		53.2	0
Aug 6/47	1624	0.12	0	7.9	0	3.5		53.9	0
Sept 13/47	1664	0.28	0	0.7	0	0.7		54.9	0
Oct 18/47	1706	0.14	0	10.7	0	0.53		44.4	0
Nov 8/47	1734	0.18	0	11.5	0	0.53		40.7	0
Dec 5/47	1770	0.28	0	10.4	0	1.3		37.6	0
Jan 2/48	1799	0.25	0	10.5	0	0.89		34.4	0
Feb 6/48	1823	0.25	0.05	11.5	0	0.75		32.9	0
March 6/48	1873	0.24	0	9.2	0	0.89		31.5	0
April 10/48	1937	0.13	0.11	10.0	0.7	1.3		53.2	0
Average (12 Samples)		0.175		10.4		1.6		43.5	0
STATION NO. 72: RIDEAU RIVER AT INTAKE TO WATER WORKS, SMITHS FALLS, ONTARIO									
March 7/47	1384	0.04	0.01	18.5	0	3.5	0.03	107.8	0
April to August	NO SAMPLES TAKEN								
Sept 26/47	2025	0.06		10.4	0	4.0		86.4 (87.8)	0

TABLE 3-17C (Cont'd)

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Iron as Fe Total	Nitrite (NO_2)	Sulphate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Phosphate (PO_4)	Bio-carbonate (BCO_3)	Carbonate (CO_3)
STATION NO. 73: TAY RIVER AT PERTH, ONTARIO									
Sept 25/47	2107	0.004		13.2	0	6.2		76.4 (74.4)	0 (0)
STATION NO. 76: MISSISSIPPI RIVER NEAR APPLETON, ONTARIO - DRAINAGE AREA 1,150 SQUARE MILES									
May 6/47	1446	0.03	0	18.5	0	2.7		79.1	0
STATION NO. 77: MISSISSIPPI RIVER AT CARLETON PLACE, ONTARIO									
March 7/47	1385	0.03		20.6	0	3.5	0	105.7	0
STATION NO. 78: SHARBOT LAKE NEAR SHARBOT LAKE, ONTARIO									
Sept 25/47	2092	0.01		18.1	0	3.5		103.7 (100)	0
STATION NO. 79: MADAWASKA RIVER AT WATER WORKS, ARNPRIOR, ONTARIO									
Sept 15/47	2036	0.06		8.1	0	4.1		59.8 (58.6)	0 (0)

TABLE 3-17D (Cont'd)

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

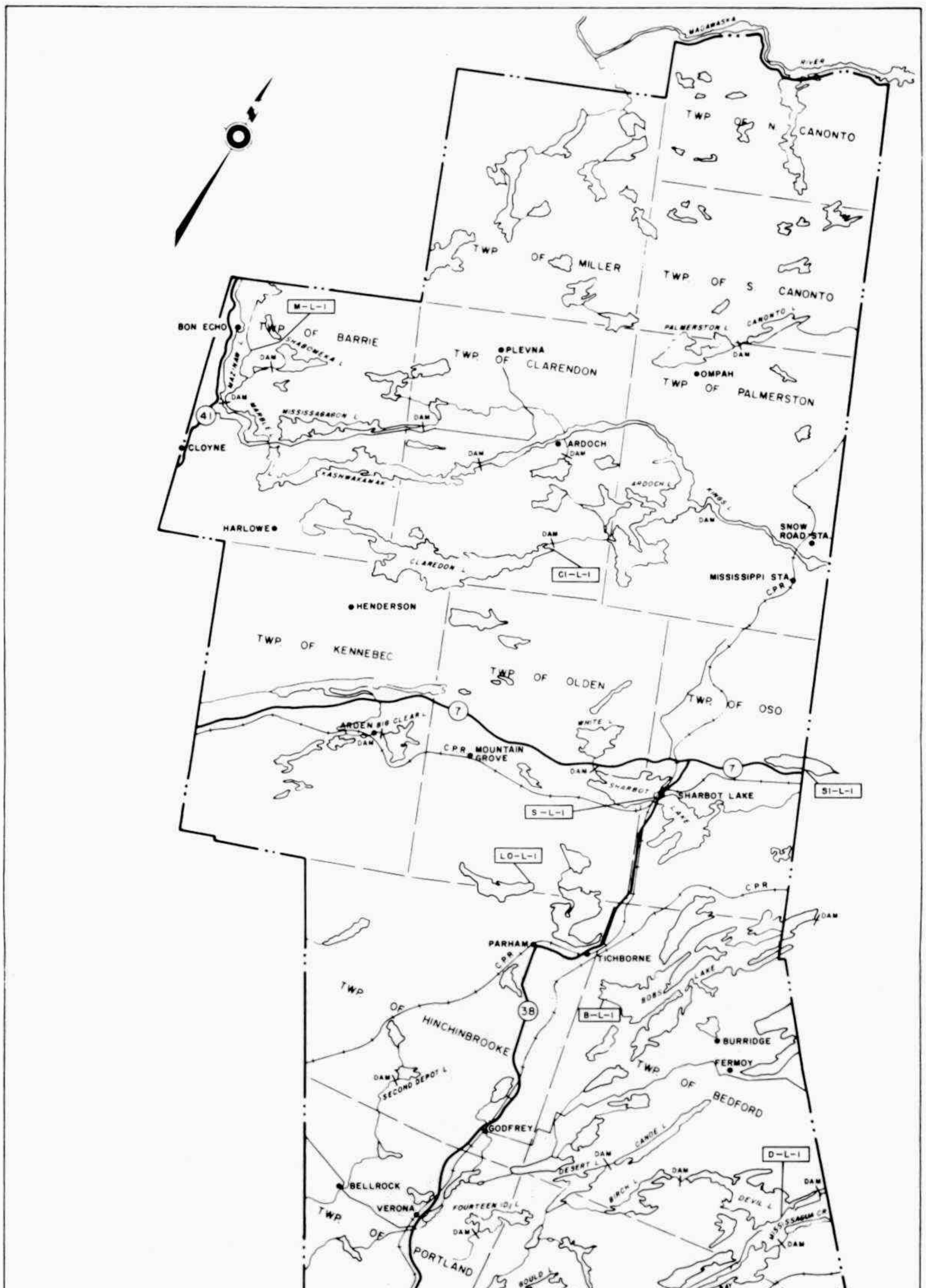
Date of Collection	Sample Number	Silica (SiO_2) Gravimetric	Silica (SiO_2) Colorimetric	Hardness as $CaCO_3$ Non-carbonate	Hardness as $CaCO_3$ Total	Ca / Mg Ratio	Per Cent Sodium	Saturation Index +	Saturation Index −
STATION NO. 73: TAY RIVER AT PERTH, ONTARIO									
Sept 25/47	2107		8.6	14.1	76.7	4.15	12.8		0.03
STATION NO. 76: MISSISSIPPI RIVER NEAR APPLETON, ONTARIO - DRAINAGE AREA 1,150 SQUARE MILES									
May 6/47	1446	2.5	4.4	15.8	80.6	3.24	17.9		0.05
STATION NO. 77: MISSISSIPPI RIVER AT CARLETON PLACE, ONTARIO									
March 7/47	1385	5.0		29.5	116.1	5.00	11.2		0.4
STATION NO. 78: SHARBOT LAKE NEAR SHARBOT LAKE, ONTARIO									
Sept 25/47	2092		5.8	20.5	105.5	4.22	1.1		1.0
STATION NO. 79: MADAWASKA RIVER AT WATER WORKS, ARNPRIOR, ONTARIO									
Sept 15/47	2036		10.0 (4.0)	6.1	55.1	5.25	9.4		0.4

TABLE 3-17D

CHEMICAL ANALYSES OF RAW SURFACE WATERS IN OTTAWA RIVER WATERSHED
(in parts per million)

Date of Collection	Sample Number	Silica (SiO_2) Gravimetric	Silica (SiO_2) Colorimetric	Hardness as $CaCO_3$ Non-carbonate	Hardness as $CaCO_3$ Total	Ca / Mg Ratio	Per Cent Sodium	Saturation Index +	Saturation Index −
STATION NO. 80: MADAWASKA RIVER ABOVE ARNPRIOR - DRAINAGE AREA 3,185 SQUARE MILES									
May 9/47	1458	4.5	5.6	10.8	42.6	4.67	33.1		1.4
June 12/47	1504	5.0	4.8	8.4	46.8	5.04	5.8		1.2
July 7/47	1590	9.4	2.9	7.8	51.4	4.61	17.3		1.1
Aug 6/47	1624	6.2	2.8	9.0	53.2	4.82	9.3		1.2
Sept 13/47	1664	6.2	5.1	9.6	54.6	5.42	14.9		1.0
Oct 18/47	1706	6.8	5.2	17.2	53.6	2.81	2.7		1.3
Nov 8/47	1734	4.8	5.6	5.2	38.6	4.07	15.2		1.4
Dec 5/47	1779	6.8	4.0	7.0	37.8	3.75	18.4		1.5
Jan 2/48	1799	10.6	4.8	15.4	43.6	2.42	6.5		1.4
Feb 6/48	1823	8.2	4.8	6.6	33.6	3.33	14.4 (11.1)		1.7
March 6/48	1873	6.4	2.6	5.7	31.5	2.86	20.2 (18.3)		1.9
April 10/48	1937	7.0	4.4	21.2	64.8	6.21	5.7 (4.7)		1.1
Average (12 Samples)		6.8	4.4	10.3	46.0	4.17	13.4		1.3
STATION NO. 72: RIDEAU RIVER AT INTAKE TO WATER WORKS, SMITHS FALLS, ONTARIO									
March 7/47	1384	3.0		23.3	111.7	4.57	8.9		0.4
April to August	N O	S A M P L E S		T A K E N					
Sept 26/47	2025		4.0	25.1	95.9	3.62		0.22	


ONTARIO WATER RESOURCES COMMISSION
COUNTY OF FRONTENAC
(SOUTHERN PORTION)
FIGURE 3-1
SCALE: MILES
DRAWN BY: H.G.
DATE: DEC. 1964
CHECKED BY:
DRAWING No: 64-95
LEGEND
LO-266-2 - LAKE AND RIVER SAMPLING POINT
- WATER WORKS INTAKE
- SEWAGE TREATMENT PLANT
X - BATHING AREAS
NOTE
FOR NORTHERN SECTION SAMPLING POINTS REFER TO FIGURE 3-2
TOWNSHIP OF ERNESTOWN
COUNTY OF LENNOX AND ADDINGTON
TOWNSHIP OF KINGSTON
TOWNSHIP OF PITTSBURGH
TOWNSHIP OF LEEDS AND LANSDOWNE
COUNTY OF LEEDS
CITY OF KINGSTON
TWP. OF HOWE ISLAND
TWP. OF WOLFE ISLAND
SIMCOE ISLAND
GARDEN ISLAND
LAKE ONTARIO
ST. LAWRENCE RIVER
RIDEAU CANAL
CATARAQUI RIVER
CATARAQUI CREEK
COLLINS CREEK
COLLINS BAY
COLLINS LAKE
INVERARY LAKE
CRANBERRY LAKE
WEST BROOK
LITTLE CATARAQUI CREEK
BUTTERNUT CREEK
STEVENTOWN CREEK
JOHNSON BAY
O.W.R.C. DEFINED BOUNDARY
SHARPTON
INVERARY
WESTBROOK
CATARAQUI
AMHERSTVIEW
AIRPORT
LAMOINE POINT
PLEASANT POINT
CARRUTHERS POINT
POINT FREDERICK
CARTWRIGHT POINT
MILTON ISLAND
MILTON POINT
TREASURE ISLAND
BARRIEFIELD ARMY CAMP
MAPLE LAWN
KINGSTON MILLS
CUSHENDALL
KILBIRNIE
FERRY
GLENBURNIE ROAD
PORTLAND ROAD
PERTH ROAD
BATTERSEA ROAD
YORK ROAD
BATH ROAD
McADOOS LANE
MIDDLE ROAD
POINT ROAD
WOODBURN ROAD
C.P.R.
C.N.R.
401
2
15
33
38
95
96
LL-1
CL-1
CO-26
CO-0-1
CO-2-8
CC-2-3
CC-1-9
CC-0-0
C-1-7B
C-1-3
C-1-8
C-1-7
C-4-7
C-5-1
C-5-2
C-11-6
C-0-7
LO-264-4
LO-264-15
LO-264-6
LO-266-2
SL-145-8
SL-144-6
SL-144-1
SL-144-8
SL-143-5
SL-141-8
SL-142
SL-141-2
SL-139-4
SL-138-8
SL-138-5
SL-137-2
SL-136-7
SL-136-3
SL-136-1
SL-134-2
SL-131-6
SL-123-3
SLWI-139
W.W.
S.T.P.


MADAWASKA RIVER
TWP. OF N. CANONTO
TWP. OF MILLER
TWP. OF S. CANONTO
M-L-I
BON ECHO
TWP. OF BARRIE
PLEVNA
TWP. OF CLARENDON
PALMERSTON L.
CANONTO L.
OMPAH
TWP. OF PALMERSTON
MISSISSAGAGON L.
41
CLOYNE
ARDOCH
KASHWAKAMAK
HARLOWE
SNOW ROAD STA.
CLAREDON L.
Cl-L-I
MISSISSIPPI STA.
C.P.R.
HENDERSON
TWP. OF KENNEBEC
TWP. OF OLDEN
TWP. OF OSO
7
ARDEN
BIG CLEAR L.
C.P.R.
MOUNTAIN GROVE
WHITE L.
SHARBOT LAKE
SI-L-I
S-L-I
LO-L-I
C.P.R.
PARHAM
TICHBORNE
TWP. OF HINCHINBROOKE
38
B-L-I
BOBS LAKE
BURRIDGE
FERMOY
TWP. OF BEDFORD
SECOND DEPOT L.
GODFREY
DESERT L.
CANOE L.
D-L-I
BELLROCK
VERONA
FOURTEEN ISL. L.
BIRCH L.
DEVIL L.
MISSISSAGUA CR.
TWP. OF PORTLAND
SOUTH BAY
OPINICON L.
HARROWSMITH
LOWER ROCK L.
TWP. OF LOUGHBOROUGH
C.N.R.
SYDENHAM
SYDENHAM L.
SY-L-I
L-L-2
C-22.8
RAILTON
TWP. OF STORRINGTON
LOUGHBOROUGH LAKE
INVERARY
C-L-I
BATTERSEA
L-L-I
COLLINS LAKE
SUNBURY
TWP. OF KINGSTON
CRANBERRY L.
ELGINBURG
BREWERS MILLS
WESTBROOK
CATARAQUI RIVER
2
15
JOYCEVILLE
COLLINS BAY
33
CATARAQUI
C.N.R.
CITY OF KINGSTON
TWP. OF PITTSBURGH
BARRIEFIELD
ST. LAWRENCE RIVER
TWP. OF HOWE IS.
WOLFE IS.
96
TWP. OF WOLFE IS.
95
UNITED STATES
LEGEND
SY-L-I LAKE AND RIVER SAMPLING POINT
ONTARIO WATER RESOURCES COMMISSION
COUNTY OF FRONTENAC
FIGURE 3-2
SCALE: 0 1 2 3 4 5 MILES
DRAWN BY A.R.S.
DATE DEC., 1964
CHECKED BY
DRAWING Nº 64-97

CHAPTER 4

CITY OF KINGSTON

CHAPTER 4

CITY OF KINGSTON

I GENERAL

The City of Kingston is located on the north shore of Lake Ontario at its outlet where the St. Lawrence River begins. The total area within the present city boundaries is 15,690 acres and the assessed population for 1964 was 51,451 persons. The Cataraqui River, part of the Rideau Canal system, enters the lake at Kingston and forms the eastern boundary of the city. Cataraqui Creek approximates the western boundary.

The three major waterways, Lake Ontario, St.Lawrence River, and Cataraqui River, have been closely associated with historical development of the area from an early Indian meeting place and later as a trading post and military fort. The military area is east and adjacent to the city's eastern boundary and continues to exert considerable influence on the economy of Kingston. Other important government establishments in the city are the federal penal institutions and the Ontario Hospital. In addition, higher education is provided by Queens University and Regiopolis College.

Industrial activity in and near Kingston has increased markedly since the termination of World War II. This has been influenced in part by Great Lakes shipping developments. In addition, the area is served by main rail routes and major highways.

II WATER SUPPLY

1. Sources

Operated by the Kingston Public Utilities Commission the Kingston municipal supply is obtained from Lake Ontario. In addition, Kingston Penitentiary obtains water from the lake for domestic purposes. The Kingston Grain Elevator and the Cataraqui Golf and Country Club use lake water for purposes other than domestic. Water from the Cataraqui River is used for industrial requirements by the A. Davis and Son Limited tannery.

2. Treatment and Capacity

The city water supply is drawn from Lake Ontario by means of a 30-inch diameter steel pipe which extends 1,200 feet from shore. The average depth of water at the inlet is 56 feet. Water enters the low lift suction well by gravity and is delivered by low lift pumps to the mixing and settling basins. Alum is employed for flocculation purposes. The water proceeds by gravity to the rapid sand filters and thence to the clear water reservoir. Pre- and post-chlorination treatment is also provided.

The nominal plant capacity based on the filters is 10 million gpd. It is considered that,during peak demand periods in summer, the filter rate can be increased 40 per cent above rated capacity due to the clarity of the raw water.

At present, storage is provided by means of a one million gallon, ground level, clear water reservoir and a 750,000-gallon elevated tank. In addition, construction is proceeding on a five million-gallon ground-level reservoir and booster pumping station. These works are located in the central part of the city, north of the Highway 2 traffic circle.

3. Water Consumption

The system supplies water to the city and the army camp located at Barriefield in the Township of Pittsburgh. The total estimated population served in 1963 was 55,700 persons.

During 1963 the average and maximum daily consumptions were 8.2 and 11.5 million gallons, respectively, indicating an average daily per capita consumption of 147 gallons. On July 29, 1964, a maximum daily consumption of 12.0 million gallons was reported. In 1963 the army camp used an average of 1.4 million gpd, equal to 18 per cent of the total water pumped by the city.

4. Water Quality

There is considerable variation in the bacteriological quality of the raw water. Intermittently the coliform concentration is high. A Most Probable Number (MPN) of 46,000 coliforms per 100 millilitres (ml) was experienced in one sample obtained in August 1962. During July and August of

1964 a MPN of 11,000 coliforms per 100 ml was reported on three occasions.

The possible causes of these high counts may be overflows from the city's combined sewers or the influence of the Cataraqui River. Interpretation of the quality of the raw water supply should be made with due regard to the current pattern near the mouth of the Cataraqui River and in the vicinity of the intake.

The natural physical and chemical qualities of the raw water are satisfactory. The following table is a summary of 25 samples of raw water submitted to the Commission laboratory.

	Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chloride as Cl	Colour in Hazen Units	Turbidity in Silica Units
Average	130	97	0.13	25	5	1.6
Maximum	140	102	0.27	30	5	2.1
Minimum	116	90	0.05	21	5	1.1

There are two water quality problems related to algae and phenol in the raw water. The presence of algae results in shortened filter runs and/or taste and odour problems, whereas the phenol produces only the latter problem. In the past these problems have been of short duration; however, taste and odours have recently persisted for significant periods of time. For this reason consideration is now being given to various taste and odour treatment methods.

5. Distribution

The distribution system extends throughout the developed area of the city and to the army camp at Barriefield. The largest diameter mains are 24-inch, located for the most part on King Street. Reportedly, there are no low pressure area problems in the distribution system.

Water is conveyed to the army camp by means of a 16-inch diameter main, which crosses the Cataraqui River about one mile north of La Salle Causeway. The water is received at the camp at pressures of 60 to 65 psi. The pressure in the camp distribution system ranges from 50 to 75 psi and storage is provided by means of two, 50,000-gallon elevated tanks and one 500,000-gallon elevated tank.

6. Potential Additional Supplies

(a) Ground Water

The city is located in an area where the overburden is thin and could only obtain ground-water supplies from the bedrock aquifer. It is unlikely that such wells would yield sufficient water for municipal needs.

(b) Surface Water

Lake Ontario will continue to be the source of water supply for the city. There is the possibility that future developments in the area might make desirable the extension or relocation of the intake pipe. In any case the construction of a second intake would provide greater assurance of a continuous supply of water. This should be considered at the time of any plant extension.

7. Future Requirements

A recent report by the consulting engineers for the Public Utilities Commission indicates a service population of 66,500 in 1975 and 78,000 in 1985. In 1955 and 1963 the average daily consumptions amounted to 6.8 and 8.2 million gallons, respectively. This indicates an eight-year increase of 1.4 million gallons or 20.6 per cent. On this basis, the average consumption in 1972 will be 9.9 mgd, about equal to the nominal capacity of the present plant. Storage capacity of 6.75 million gallons will soon be available. In view of the increasing trend in consumption rate together with the comparatively limited storage capacity, water works extensions will probably be required within the next five years.

The growth areas in the Township of Pittsburgh adjacent to the army camp require municipal water supply facilities. The possibility of supplying water to these areas from the city should receive consideration in the future.

III WATER POLLUTION

1. Sewage Disposal

The sewerage system serves the city and the army camp. The older part of the city is served by combined sewers, whereas new areas are served by separate systems of sanitary and storm sewers. The southern, older section of the city is serviced by the lakefront interceptor, and the western

and northern sections by the Rideau Heights trunk sewer and the northern interceptor. These interceptors carry the entire sewage flow from the city and terminate at the Main or River Street pumping station located on the west bank of the Cataraqui River. Sewage is pumped to the high area on the east side of the Cataraqui River at Barriefield Hill and then flows by gravity to the sewage treatment plant. The gravity section of the sewer receives sewage from the army camp. The interceptor sewers are designed to carry three times dry weather flow.

The sewage treatment plant is located on the St.Lawrence River in the Township of Pittsburgh, about three miles east of the city. The plant provides primary treatment which includes screening, grit removal, and settling. The primary sludge is stabilized in two-stage digesters prior to off-site disposal. Effluent is discharged into the St.Lawrence River by means of an outfall sewer which extends 435 feet from shore. The average water depth at the outlet is 42 feet.

The plant was designed for an average daily flow of 9.0 million gallons, based on populations of 60,000 and 10,000 persons for the city and the military camp, respectively. It is estimated that about 55,700 persons are now served. On this basis the plant loading approximates 80 per cent of design capacity. Heavy hydraulic loadings attributed to infiltration are experienced, as evidenced in the following summary of monthly sewage flows for 1963.

Month	Average Day (million gallons)	Maximum Day (million gallons)
January	6.9	7.8
February	7.1	8.3
March	14.6	20.6
April	12.8	17.0
May	10.4	15.1
June	8.6	12.1
July	8.2	11.4
August	8.1	12.6
September	8.0	12.6
October	8.2	9.8
November	10.2	15.6
December	9.4	16.2

During that year the average daily flow was 9.4 million gpd. The plant inlet channel is arranged such that flows in excess of 19.0 million gpd overflow and pass directly to the river. It is indicated that raw sewage overflows to the river occur infrequently.

The efficiency of treatment over the same period is indicated by the following data.

Test	Raw Sewage (ppm)	Plant Effluent (ppm)	Per Cent Removal Efficiency
5-Day BOD	130	89	31.5
Suspended solids	116	49	57.7

The results indicate that the raw sewage is dilute. The effluent is satisfactory for the tests indicated and the degree of treatment. The efficiencies indicated are consistent with that which is expected from a primary treatment plant.

Fishermen report that in winter coarse sewage solids are observed in the river below the sewage treatment plant. These solids have reportedly coated fishing nets and accumulated in holes which were made in the ice for fishing purposes. The accumulations have been noted immediately downstream from the effluent outfall and in the bay east of Treasure Island. As overflows at the sewage treatment plant are apparently infrequent, it is possible that surcharging and overflows from the combined sewers in the older section of the city may be responsible.

Of concern are the number of overflows located in the immediate vicinity of the water works intake. As it is considered that these discharges occur frequently, the problem is being reviewed by the city engineer with the objective of ultimate elimination. A study or investigation of the lakefront interceptor sewer is suggested for the purpose of relating variations in sewage flows to sewer capacity. It is suspected that civic growth has imposed an increased load on the sewer, frequently resulting in surcharging and undesirable overflows. As required, plans should be developed to eliminate these overflows by suitable improvements to the interceptor sewer. All overflows within the city are noted on Figure 4-1.

The bacteriological quality of the river shows a marked deterioration in the Milton Island area downstream from the sewage treatment plant. On July 21, 1964, the following sample results were obtained.

Sample Number	Sample Location	Coliforms per 100 ml
SL 137.2	Sewage treatment plant dock upstream of effluent	37
SL 136.3	Opposite Glen Lawrence	11,000

It should be noted that the destroying or removing of bacteria is only incidental to the type of treatment provided at this plant. Effective control can be provided by adequate effluent chlorination. This additional treatment should be provided on a year-round basis because of possible effects on drinking water supplies located downstream.

2. Industrial Waste Disposal

All major industrial activity in the county is located in and near the city. Twelve industries with liquid wastes were investigated, of which eight utilize the municipal sewers. Two of the remaining discharge wastes to surface watercourses and two discharge to both municipal sewers and surface watercourses.

A few industries discharge considerable volumes of cooling water to sanitary sewers. Where possible, consideration might be given to redirecting these waters to storm drainage systems providing the waste cooling water is uncontaminated and other polluted wastewaters can be disposed of suitably. This could relieve unnecessary hydraulic loading on the sewage treatment plant and would probably require pre-treatment of concentrated wastewaters before discharge to sanitary sewers.

Wastewater from the soft drink bottling industry is discharged to sanitary sewers. Care should be exercised by this industry in disposal of strong caustic bottle washing waters to sewer. Protection of the sewerage system from corrosion and other effects can be satisfactorily controlled by waste dilution or neutralization.

A summary of the waste loadings being discharged by industries to streams is given in Table 4-1. Four of the industries with water pollution problems are discussed following.

Table 4-1

Summary of Waste Loadings being Discharged to Watercourses in City of Kingston

	Aluminum Co.of Canada	A.Davis & Son Limited	Frontenac Floor & Wall Tile Ltd.	Canadian Locomotive Co. Ltd.
Receiving Watercourse	Little Cataraqui Creek	Cataraqui River	Cataraqui River	St. Lawrence River
Waste Flow (gpd)	334,000	40-50,000	20,000	18,000
5-Day BOD (lbs/day)	111	530	1	-
Suspended Solids (lbs/day)	307	600	340	-
Ether Solubles (lbs/day)	57	150	-	-
Phenols (lbs/day)	0.02	-	-	-
Chromium as Cr (lbs/day)	-	30	-	-

Aluminum Company of Canada Limited

The company produces aluminum sheet, foil, extruded shapes and forgings from scrap and ingot aluminum. A portion of the sheet is painted. The processes used are casting, hot and cold rolling, extruding, drop forging, and heat treating.

Sanitary wastes,process wastes from the South Plant, laboratory wastes from the Aluminum Laboratory,and a portion of the wastes from a paint line in the North Plant are discharged to municipal sanitary sewers. Wastewater from an unknown source in the South Plant is discharged to the Princess Street municipal storm sewer which in turn empties into the Little Cataraqui Creek. Process wastewater from the North and Centre Plants is discharged through drainage ditches to

the Little Cataraqui Creek. Data on the wastewater discharges are summarized in Table 4-2.

The discharge from the paint line in the South Plant contained excessive loadings of 5-Day BOD, suspended solids, and ether solubles. The company is considering installation of a new type of pre-treatment process which is expected to reduce the concentrations of polluting wastes. Unless this arrangement provides effective control, provision should be made to direct the wastewater to the sanitary sewer.

One discharge to the creek from the North Plant was found to have a pH of 10.1 while another was found to have a suspended solids concentration of 133 ppm. These discharges should be treated to comply with water quality objectives.

Canadian Locomotive Company Limited

The plant manufactures diesel engines, large weigh scales, and liquid pumps. Water consumption is estimated at 18,000 gpd.

Industrial wastes include boiler blowdown, water used to wash engines, to test engine water-jackets for leaks, and to cool the rheostat which is used to dissipate heat produced by the engines during testing. Part of the plant wastes is directed to municipal sanitary sewers while the remainder is discharged to the St. Lawrence River. A study is being made of the problem of directing these remaining discharges to the municipal system.

A. Davis and Son Limited

This plant produces boot and shoe upper leather from cow hides by the chrome tan process. A reported 40-50 thousand gpd are supplied by the city and drawn from the Cataraqui River for process purposes.

Both process and sanitary wastes are discharged untreated to the Cataraqui River by way of a ditch that passes through a swampy area.

The mixed effluent has exhibited the following characteristics. The total waste loading is shown in pounds per day.

TABLE 4-2

ALUMINUM COMPANY OF CANADA LIMITED - SUMMARY OF WASTE LOADINGS

Source of Waste	Estimated Flow thousand gals/day	pH at Lab.	5-Day BOD ppm	5-Day BOD lbs/day	Suspended Solids ppm	Suspended Solids lbs/day	Ether Solubles ppm	Ether Solubles lbs/day	Aluminum as Cl ppm	Aluminum as Cl lbs/day
North Plant to Creek										
West Outfall	24	10.1	12	2.9	21	5.0	2	0.5	1,320	317
Middle Outfall	117	7.5	7	8.2	1	1.2	3	3.5	0.3	0.4
East Outfall	24	9.4	16	3.8	133	32.0	3	0.8	70	16.8
Total North Plant to Creek	165			14.9		38.2		4.8		334.2
Centre Plant to Creek	19	7.3	20	3.9	6	1.1	8	1.5	0.4	0.8
South Plant to Creek										
via Princess Street storm sewer	150	9.2	62	92	181	268	35	51.6	2.7	4.0
Total to Creek	334			110.8		307.3		57.9		339.0
Total to Princess Street sanitary sewer	404		155	626	108	436	165	666		
Total Waste Loadings	738			736.8		743.3		723.9		

All samples were composited hourly between 9:00 a.m. and 5:00 p.m.

	Concentration (ppm)	Loading (lbs/day)
5-day BOD	1,100	530
Suspended solids	1,200	600
Total Chromium	60	30
Sulphides	20	10
Ether Solubles	300	150
pH	9.0 - 10.0	

The company has been requested to provide either (1) waste treatment to produce an effluent acceptable for discharge to the Cataraqui River, or (2) pre-treatment facilities to include screening and settling before discharge to municipal sewer. Recently agreement has been reached between the company and the city to provide for acceptance of tannery wastes into sanitary sewer for treatment by the municipality. This project is expected to proceed immediately on the basis of a trial period of one year, following which treatment and service costs will be appraised.

Frontenac Floor and Wall Tile Limited

This plant produces ceramic floor and wall tiles by pressing various clays, mixed in water, into tiles. These are fired and then coated with glazed materials, such as clay, lead, glass, silica, and various colours which have been mixed in water. Following coating with glazed materials, the tile is again fired. When a mix of a different colour is made, the mill is washed out with water to waste. About 22,000 gpd of water are used for sanitary and plant purposes.

Mill wash water is discharged to a newly installed settling basin from which 4 to 5 barrels of solids are recovered each week. The settling basin effluent is conveyed to a small watercourse tributary to the Cataraqui River. Improvements are planned in the disposal of sanitary wastes to eliminate the present effluent discharge to the stream. The plant effluent characteristics are given as follows.

	5-Day BOD	Solids Total	Solids Susp.	Solids Diss.
Total effluent from plant	5.2	1,758	1,572	186

Composite: 9:00 a.m. to 3:00 p.m.

The newly installed settling basin does not provide adequate settling and improvements have been proposed by the company.

Comment

The need for an industrial wastewater control by-law to provide for protection and reasonable use of sewerage and treatment facilities is clearly indicated. Such legislation would provide industry with a clear and equitable guide to waste disposal requirements.

3. Refuse Disposal

Refuse from the City of Kingston and the Township of Pittsburgh, including the army camp, is presently deposited in an area on the west side of the Cataraqui River adjacent to Belle Island. The site, which is nearly exhausted for landfill purposes, is operated satisfactorily. A new area immediately north of the present operation is to be used in the future. Because the new location is predominantly marshy, an impervious berm should be constructed around the site to prevent the escape of polluted seepage to the river.

4. Surface Water Quality

The results of river and lake samples are summarized in Tables 3-8, 3-9, and 3-10. The locations of sampling points are noted on Figure 3-1.

Adverse conditions were noted in the Cataraqui River below Belle Island and in Cataraqui Creek at Highway 2. These problems are attributed to wastewater discharges from the A. Davis and Son Limited tannery and the Aluminum Company of Canada, respectively.

The bacteriological data contained in Table 3-8 pertaining to stream sampling stations in the vicinity of the city indicate generally satisfactory conditions. Samples obtained by the City of Kingston Health Department have shown pollution opposite the Cataraqui Golf and Country Club and at the east end of the city. The former is thought to be due to contaminated seepage from the golf club. The latter could possibly be related to either overflows from the interceptor sewer or contamination from the Cataraqui River. It is considered that part of the flow from the Cataraqui River may exert an influence on the water in the vicinity of the city water works intake. Samples obtained at the

MacDonald Park and Lake Ontario Park bathing beaches have been satisfactory this year.

The Cataraqui River south of Belle Island is polluted by wastes from the A. Davis and Son Limited tannery. These wastes contribute to high BOD, chrome, and coliform concentrations, and result in the creation of objectionable sludge banks. Decomposition of the latter produces odour nuisances which have given rise to several complaints from this section of the city.

5. Future Requirements

The sewage treatment plant is operating at hydraulic design capacity. In view of the dilute nature of the raw sewage and the quality of the effluent, the capacity may be considered as adequate for the present. A substantial increase in sewage flow would require a plant expansion. The most pressing need is adequate chlorination facilities for effluent disinfection.

In view of proximity of the developing part of the Township of Pittsburgh to the city, the possibility of providing sewage service to this municipality should be considered in future planning.

IV CONCLUSIONS

1. Water Supply

The average and maximum daily pumpages from the water purification plant approximate 8 and 12 million gpd, respectively. These demands, in conjunction with the expected increase in population, indicate that water works expansion will be necessary within five years. In planning for such expansion, the extent to which the water works may serve adjacent developing township areas should be considered.

2. Pollution Control

Present effluent characteristics and treatment efficiency indicates that the sewage treatment plant capacity is adequate at the present time.

The contamination of the Cataraqui River near Belle Island indicates the need for adequate treatment of all wastes from the A. Davis and Son Limited tannery.

Control of the discharge to Cataraqui Creek of polluting plant wastes requires the provision of suitable treatment facilities by the Aluminum Company of Canada Limited.

All wastes from the Canadian Locomotive Company Limited should be directed to the city's sanitary sewers.

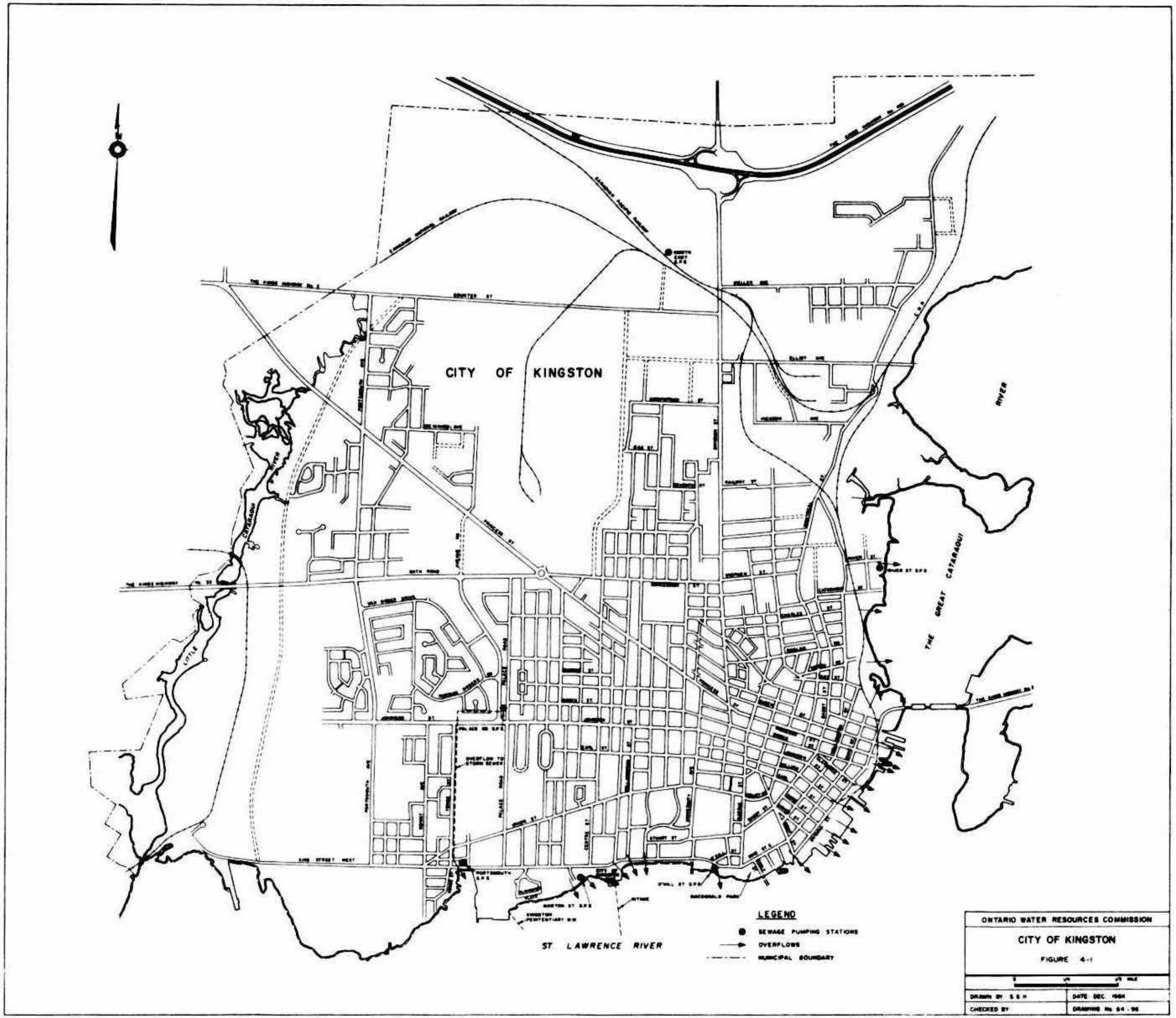
The Frontenac Floor and Wall Tile Limited should proceed as soon as possible with plans for treating the process and sanitary wastes from the plant. This will require the installation of improved settling facilities for the process waste and a field tile disposal bed for the effluent from the septic tank.

Sanitary sewage is causing pollution of Lake Ontario opposite the Cataraqui Golf and Country Club. This matter is being investigated by the City of Kingston Health Department.

The reasonable use of municipal sewerage and treatment facilities by industries is desirable. This can be best achieved by enactment and implementation of an industrial waste control by-law which would establish suitable limits for strong trade wastes discharged to municipal sewers.

Development in the adjacent area of the Township of Pittsburgh requires municipal sewage service. The possibility of joint treatment arrangements between the city and the township, utilizing the Kingston sewage treatment plant, should be considered.

The bacteriological condition of the St. Lawrence River downstream from the sewage treatment plant indicates the need for effluent disinfection. The need for a study of the lakefront interceptor sewer capacity is indicated. Every effort should be made to remove the overflow sewers, especially in the area of the water works, as soon as possible.


CITY OF KINGSTON
THE GREAT CATARAQUI RIVER
LITTLE CATARAQUI RIVER
ST. LAWRENCE RIVER
LEGEND
SEWAGE PUMPING STATIONS
OVERFLOWS
MUNICIPAL BOUNDARY
ONTARIO WATER RESOURCES COMMISSION
CITY OF KINGSTON
FIGURE 4-1
CHECKED BY

<u>CHAPTER 5</u>

<u>TOWNSHIP OF KINGSTON</u>

CHAPTER 5

TOWNSHIP OF KINGSTON

I GENERAL

The Township of Kingston is located immediately west and north of the City of Kingston. From a five-mile frontage along Lake Ontario, the township extends north for ten miles. The total area is approximately 52,000 acres and the 1964 population was reported as 11,300 persons.

The two largest industries are DuPont of Canada Limited and a terminal of Trans-Canada Pipeline Limited. A number of smaller industries have been established recently.

The Federal Government owns two large tracts of land in Concession I, Collins Bay Penitentiary and Norman Rogers Aerodrome. Some industries have been established in the former RCAF buildings located at the aerodrome; however, the final disposition of the aerodrome land has not been decided.

II WATER SUPPLY

1. Municipal Supplies

There are three municipally owned and operated water systems. The Point Pleasant and Queen's Acres obtain water from Lake Ontario, whereas, the Westbrook Heights system utilizes ground water.

(a) Point Pleasant

Two gravity intake pipes, 10 and 16 inches in diameter, extend about 700 feet into the bay to a depth of 16 feet. The capacity of the water works is related to the two pumps which have a total output of 1.44 million gallons per day. In addition, an elevated tank provides storage for 250,000 gallons. There are two booster pumping stations.

Since screening and chlorination are the only treatment provided, there are intermittent problems due to turbidity and algae. These problems could be readily handled by complete filtration treatment.

The daily average and maximum pumpages during 1963 were 234,000 and 941,000 gallons, respectively. Considerable variation between the average and maximum days is indicated. Since peak pumpages occur in summer months and the large percentage of use is residential, the probable reason is lawn watering. The population served by the 1,330 services is estimated to be 5,320 persons. On this basis, the average daily per capita consumption for 1963 was 44 gallons.

The average chemical quality of the water based on samples submitted since 1962 is given here.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	pH at Lab.	Chloride as Cl	Colour in Hazen Units	Turbidity in Silica Units
134	100	0.1	7.9	24	<5	1.0

The largest diameter main is 12 inches and low pressure problems have been limited. As the service area continues to be extended, consideration should be given to installation of large diameter reinforcing mains.

The area to be serviced by the system is shown on Figure 5-1 and will eventually be extended to connect with the Queen's Acres system. At present the distance separating the two systems is 0.6 miles. Interconnection with the Westbrook Heights system will be delayed because of the intervening marsh area along Highway 2 between Westbrook Heights and the main water service area.

(b) Queen's Acres

A six-inch diameter gravity intake pipe extends 160 feet into the lake and is located near the outlet of Collins Bay. A temporary plastic intake pipe has been utilized during periods when lake levels have been low. The total output of the two general duty pumps is 325,000 gallons per day. There is no system storage.

Coarse screening and disinfection by means of a hypochlorinator are provided. Problems due to intermittent turbidity have been reported by consumers. The problem is more pronounced during the run-off period in the spring.

There are 170 services supplying an estimated 680 persons. On the basis of pumpage information from the Point Pleasant system, the average water consumption for Queen's Acres has been estimated to approximate 30,000 gallons per day.

The chemical quality of the supply is indicated by sample results averaged since 1962.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	pH at Lab.	Chloride as Cl	Colour in Hazen Units	Turbidity in Silica Units
132	101	0.2	8.0	23	<5	1.4

The increasing demands for extension of the original limited service area have been met by installing six-inch diameter mains. This has resulted in areas of low pressure especially during the summer months when much water is used for lawns and gardens.

(c) Westbrook Heights

The Westbrook Heights water works obtains water from a ten-inch diameter well 94 feet deep. The well pump, with capacity of 115,000 gpd, discharges to a 77,500-gallon ground level reservoir. Two pumps with a total capacity of 288,000 gallons per day supply the distribution system. Pressure in the distribution system is regulated with the aid of a 1,000-gallon hydropneumatic tank.

The water is disinfected by means of an electrically driven hypochlorinator which injects hypochlorite solution into the discharge of the distribution pumps. There have been frequent occasions when the chlorine residual in the water leaving the pumphouse has been inadequate. The bedrock in this area is partly fissured limestone and lies at or near the surface in part of the developed area served by sub-surface sewage disposal systems. The rock fissures may allow contamination to travel for considerable distances. In view of the possibility of contamination of the water supply, it is most important that adequate disinfection be provided at all times. This can be achieved by both pre- and post-chlorination at the pumphouse.

As for the Queen's Acres system, no flow meter is available at the Westbrook Heights pumphouse. There are 125 services representing an estimated population of 500 persons. On the basis of pump capacity and duration of pumping, the average consumption is estimated to be about 35,000 gallons per day.

The average chemical quality of the water based on samples obtained since 1961 is indicated.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chlorides as Cl	pH at Lab.
160	280	0.1	318	7.4

In addition to the high hardness, the chloride content is above the recommended concentration of 250 parts per million. This is largely a matter of taste; however, it may be of concern to persons on restricted diets. The well water at Westbrook Heights has both the advantages and disadvantages of most well waters. It is cold and refreshing for drinking but hard and not too suitable for washing purposes unless softened.

A taste problem developed in the supply early in 1960. This was attributed to gasoline contamination related to a fire at a nearby gasoline service station. The problem was most pronounced immediately after the fire, but persisted intermittently for three years. There have been no recent complaints.

The diameter of most of the mains is six inches, although there is a 1,300-foot section of ten-inch diameter main near the pumphouse. Due to the concentrated service area and the looping mains, there have not been any serious low pressure problems in this system.

2. Private Supplies

(a) Ground Water

Private ground-water supplies in the Township of Kingston are obtained from dug and drilled wells.

Because of the shallow overburden, most wells are drilled into limestone bedrock in order to obtain sufficient supply. Depth of penetration ranges from 23 to 214 feet. Quality is extremely variable ranging from fresh to salty

and sulphurous. Areas of particularly poor quality water include the communities of Elginburg, Cataraqui, and Collins Bay. Many dry wells have been drilled in the township. There have been complaints of inadequate supply of water in some of the private wells located in the Aylesworth Subdivision which is located on the Sydenham Road and in the Woodbine Road-Highway 2 area.

Some overburden deposits, particularly near the western boundary of the city, extend to depths greater than 100 feet but are composed of fine grained materials and cannot be considered good sources of ground water.

The use of dug wells is not common except in some sandy areas. Lowered water levels during summer periods have seriously affected the supply available from such wells. Fresh good quality water is reportedly obtained from the dug wells.

(b) Surface Water

In addition to the municipal systems, there are three privately owned systems which draw water from Lake Ontario. The largest serves DuPont of Canada Limited for both process and domestic water requirements. Treatment consists of screening and chlorination. Similar treatment is afforded the water obtained for the Kingston Penitentiary system. Treated water from Kingston Penitentiary is pumped to Collins Bay Penitentiary. Untreated water is pumped from the lake to supply process water to industries located at Norman Rogers Aerodrome.

At present the only township service supplied by City of Kingston water is at Collins Bay Penitentiary. This connection is made via the Kingston Penitentiary and is used only for emergencies.

3. Potential Additional Supplies

(a) Ground Water

Adequate domestic supplies are available locally in the bedrock. In certain areas, ground-water yields appear favourable and suggest that the aquifer may be capable of supplying a small communal system. Caution would be required in the selection of test-drilling sites and depth of penetration as salty and sulphurous waters are commonly encountered in the bedrock.

Overburden deposits do not appear to be satisfactory for the development of supplies beyond those required for private, domestic needs.

(b) Surface Water

Lake Ontario is the logical source of municipal supply for the township. The matter of intake and filtration plant location will require special study.

4. Future Requirements

At present the township is served by three municipal systems which supply water to an estimated 6,500 persons or 60 per cent of the township population. For purposes of economy and improved operation, the three systems should be eventually interconnected.

It will become necessary to construct a complete filtration plant. Because the Queen's Acres and Point Pleasant water works systems are not well situated due to location on bays in both cases, a more suitable site, possibly in the Lemoine Point area, should be considered.

The City of Kingston Planning Board has predicted a population of 45,000 persons for the Township of Kingston by 1980. On this basis, an estimated 35,000 persons could reside in the water service area. This would require the provision of water works facilities capable of supplying a probable demand of 2 to 3 million gallons per day to serve the developing needs of the township.

III WATER POLLUTION

1. Sewage Treatment Facilities

The township sewer area is described on Figure 5-1. The estimated population in this area is 5,500 persons. All sewers being installed are of the separate type, that is, sanitary and storm sewers. Three pumping stations on the system include the Days Road, Crear Boulevard, and Airport Road stations.

The sewage treatment plant is located in the south-eastern section of the township, south of DuPont of Canada Limited. The effluent is discharged to Lake Ontario at Carruthers Point by means of a 36-inch diameter outfall sewer extending 630 feet from shore to a water depth of 50 feet.

The 830,000 gpd activated sludge-type treatment plant is equipped with effluent chlorination and single stage sludge digestion. Designed for present and future populations of 10,000 and 20,000 persons, respectively, the plant was put into operation in August, 1963. Since that time, with the extension of sewers, there has been a steady increase in sewage flow to the present 300,000 gallons per day.

Problems have been experienced in obtaining maximum efficiency of treatment. These have been occasioned by low average daily flows and intermittent high flows. Sample results have indicated a treatment efficiency of 65 per cent for suspended solids and 74 per cent for BOD.

The distance and direction of nearby water intakes are listed:

- DuPont of Canada Limited, 2,000 feet to the west,
- Kingston Penitentiary, 8,000 feet to the east,
- City of Kingston, 10,500 feet to the east.

The effluent from the plant has caused no known effects on the water obtained at these intakes.

2. Industrial Waste Disposal

Two significant wet waste producing industries are DuPont of Canada Limited and Vicom Company (Canada) Limited. The wastes from the Vicom Company are satisfactorily handled, whereas development of satisfactory waste disposal methods are continuing at the DuPont plant.

DuPont of Canada Limited

The plant produces nylon monofilament and nylon yarn, including tire yarn, from adipic acid and hexamethyelene diamine. At the time of inspection the plant was pumping approximately 9,630,000 gallons per day from Lake Ontario.

Wastewater is discharged through two sewers to Cataraqui Bay. The north sewer conveys process wastes and the overflow from the septic tank in which sanitary wastes are treated. The south sewer, a storm drain, conveys water from the air conditioning system in the spinning area. The results of composited effluent samples provide the following data on waste loadings.

	North Sewer	South Sewer
5-Day BOD (ppm)	14	1.1
Solids: Total (ppm)	256	222
Suspended (ppm)	27	6
Dissolved (ppm)	229	216
pH at Lab.	7.8	7.4
COD	44	27.8
Phenols in ppb	0	10
Ether Solubles	4	3

These samples were composited half-hourly between 10:00 a.m. and 3:00 p.m.

Estimated Waste Loadings	North Sewer	South Sewer	Total
Flow (gpd) 1,000 x	1,370	8,260	9,630
5-Day BOD (lbs/day)	193	91	284
Suspended Solids (lbs/day)	372	495	867
Ether Solubles (lbs/day)	55	248	303
Phenols (lbs/day)	0	0.83	0.83

In the interests of pollution control, a number of plant changes have been made in the past five years. These have included the following measures. (1) An in-plant survey of the sewer system revealed that spin finish oil losses were the main source of phenolic contamination. The sewers in the spin finish oil make-up area were segregated and provision was made for storage of concentrated wastes for subsequent hauling to land disposal. (2) Equipment was rearranged to reduce losses of titanium oxide to sewer. (3) All spent activated carbon was separated for disposal of this waste on land. (4) Equipment was installed to provide continuous discharge of spent dye solutions rather than batch disposal. (5) Relocation of all buried pipes carrying Bunker "C" fuel oil to above ground was arranged so that leaks could be readily detected. (6) An oil trap was installed to collect any minor spills of Bunker "C" fuel oil.

Sanitary wastes which were formerly discharged to the Bay after primary treatment are now being sewered to the municipal system for treatment. Water scrubbing of a reducing furnace exhaust system is planned. Effluent will be discharged to the south sewer if acceptable.

Vicom Company (Canada) Limited

The Vicom plant manufactures diamond drilling machines, aluminum couplings, and metal parts for television sets. Approximately 7,000 gpd. are pumped from Lake Ontario to supply water to all buildings at the Norman Rogers Aerodrome. A small quantity is used by Vicom for cooling purposes.

All sanitary wastes and uncontaminated cooling waters are discharged to a septic tank, the effluent from which is chlorinated and disposed of in a tile bed. Should the tile bed become overloaded, it may be desirable to discharge uncontaminated cooling water directly to the lake.

3. Refuse Disposal

Collected refuse is disposed of at an area located north of MacAdoos Road and in line with the projection of Division Street. This area drains toward Cataraqui Creek. There has been no evidence of pollution of the creek by seepage from the refuse disposal area. However, fires probably caused by spontaneous combustion have resulted in many complaints concerning smoke and related undesirable odours.

It is estimated that 180 cubic yards of domestic refuse and 400 cubic yards of industrial refuse are deposited each week. A large amount of the industrial refuse is nylon waste from the DuPont plant. The waste materials are covered each day by soil.

4. Surface Water Quality

The results of stream and lake samples are summarized in the tables at the end of Chapter 3.

The sanitary chemical quality of Lake Ontario opposite the township is satisfactory; however, significant variation in bacteriological characteristics suggest that sources of pollution are limited in extent and probably of local origin. Early in July, 1964, the township bathing areas on the lake were posted as unsatisfactory. Although much of the area is served with sanitary sewers, many homes still employ septic tank systems. Seepage from these could be the cause of the bacterial contamination. The need for early completion of sewer service connections throughout this part of the township is indicated.

The incidence of algae growths along the lake is of growing concern to area residents. During the latter part of July, 1964, abundant deposits of algae were noted on the shore near the Point Pleasant water works. Decomposition of the algae in the shore waters results in a particularly offensive odour.

The quality of the water in the inland rivers and creeks is generally satisfactory.

5. Future Requirements

The present estimated population in the Point Pleasant-Queen's Acres water service area is 6,000 persons. The sewage treatment plant has a design capacity of 10,000 persons. Projection of current population growth rates suggests that it will be necessary to consider expansion of the sewage treatment plant within the next five years.

IV CONCLUSIONS

1. Water Supply

The chlorination facilities at the Westbrook Heights water works should be improved.

Future planning for the three municipal water distribution systems should include integration with provision for complete water filtration facilities.

Consideration should be given to installing large diameter reinforcing mains throughout the water area. Improvements in water pressures in the Queen's Acres area are required and should be co-ordinated with the overall plan.

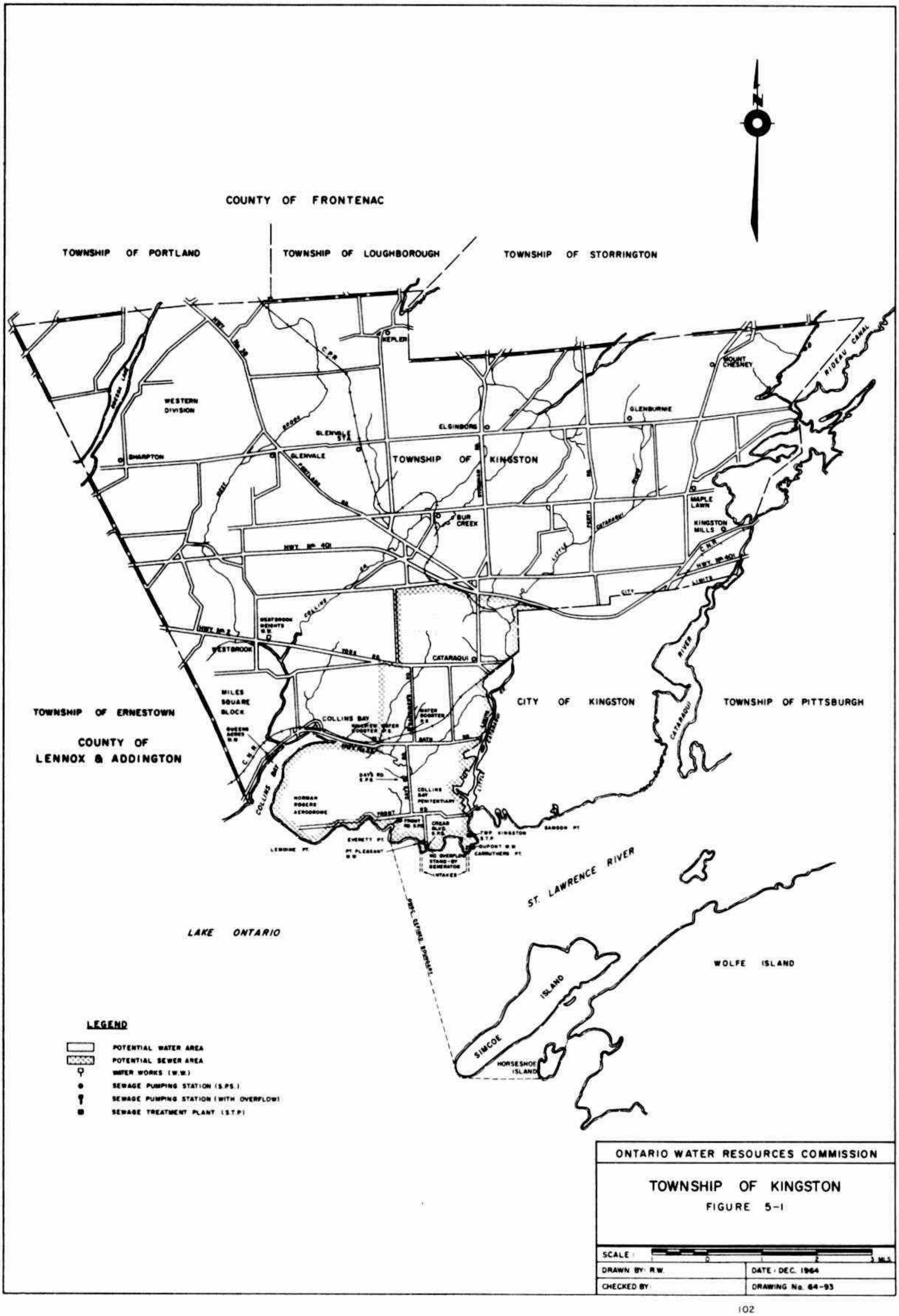
2. Pollution Control

The localized intermittent coliform concentrations in Lake Ontario indicate that early completion of sanitary sewer services in the developed part of the township is desirable.

The projected population growth suggests the probable need for expansion of the sewage treatment plant within the next five years.

With completion of the proposed changes in wastewater disposal by DuPont of Canada Limited, further appraisal of the company's water pollution control programme will be required.

Future subdivisions in the township should be developed on the basis of municipal sewers and sewage treatment.


COUNTY OF FRONTENAC
TOWNSHIP OF PORTLAND
TOWNSHIP OF LOUGHBOROUGH
TOWNSHIP OF STORRINGTON
KEPLER
MOUNT CHESNEY
RIDEAU CANAL
WESTERN DIVISION
GLENBURNIE
ELGINBURG
GLENVALE STA.
GLENVALE
SHARPTON
TOWNSHIP OF KINGSTON
MAPLE LAWN
KINGSTON MILLS
BUR CREEK
HWY No 401
HWY No 2
WESTBROOK
CATARAQUI
MILES SQUARE BLOCK
TOWNSHIP OF ERNESTOWN
COUNTY OF LENNOX & ADDINGTON
COLLINS BAY
CITY OF KINGSTON
TOWNSHIP OF PITTSBURGH
CATARAQUI RIVER
NORMAN ROGERS AERODROME
COLLINS BAY PENITENTIARY
ST. LAWRENCE RIVER
LAKE ONTARIO
WOLFE ISLAND
SIMCOE ISLAND
HORSESHOE ISLAND
LEGEND
POTENTIAL WATER AREA
POTENTIAL SEWER AREA
WATER WORKS (W.W.)
SEWAGE PUMPING STATION (S.P.S.)
SEWAGE PUMPING STATION (WITH OVERFLOW)
SEWAGE TREATMENT PLANT (S.T.P.)
ONTARIO WATER RESOURCES COMMISSION
TOWNSHIP OF KINGSTON
FIGURE 5-1
SCALE
0
1
2
3 MLS
DRAWN BY: R.W.
DATE: DEC. 1964
CHECKED BY:
DRAWING No. 64-93

CHAPTER 6

TOWNSHIP OF PITTSBURGH

CHAPTER 6

TOWNSHIP OF PITTSBURGH

I GENERAL

The Township of Pittsburgh is located immediately east of the City of Kingston. Its western and southern boundaries are formed by the Cataraqui and St. Lawrence rivers, respectively. The total area is 49,615 acres and the 1964 assessed population was 4,025 persons.

Development has been limited and due in part to the lack of adequate water supply. Two areas of concentrated population lie along Highway 15 and on Highway 2, east of the military camp. There are populations in both these areas of about 600 persons.

There are no major industries in the township, however, the military camp employs a considerable number of civilians. During 1963 the average population living on the Department of National Defence (DND) property was 5,697 persons. In addition, 1,884 day workers lived beyond the camp.

II WATER SUPPLY

1. General

All domestic supplies are obtained from privately owned dug and drilled wells.

Dug wells are usually located in clay or clayey till. Supplies from many of these have failed due to lowered water levels during summer periods and in a number of cases have been replaced with drilled wells.

Due to the lack of substantial overburden, wells are drilled into bedrock in many areas. Three distinct bedrock types are present in the township - the Black River limestone, the Potsdam sandstone, and the Precambrian sequence. Penetrations into bedrock are generally less than 100 feet. Good quality water is obtained from the Precambrian sequence and the Potsdam sandstone. The quality of waters from the limestone aquifer is variable.

The ground-water supply in the developed area is generally of insufficient quantity and unsatisfactory quality.

Several commercial developments on Highway 15 have been obliged to haul water. Many of the drilled wells in the area have problems due to hydrogen sulphide or high salt concentration. In addition to the adverse natural characteristics of the ground water, some of the wells at Cartwright Point and Ravensview Subdivision have been contaminated. In the former area the contamination is attributed to seepage of sewage material, whereas seepage from gasoline storage tanks has been an additional factor in the latter.

Other than the military camp supply from the city, there are no municipal water supply systems in the township. The 16-inch diameter supply main crosses the Cataraqui River about one mile north of La Salle Causeway. Recently there have been negotiations to extend the water supply from the army camp to service homes at Cartwright Point. There are four private water works systems which serve subdivisions and one institution in the township.

2. Private Community Supplies

(a) Cana Home Builders Co-Operative

Water supplied to 32 homes is obtained from an eight-inch diameter, 55-foot deep drilled well. The water is pumped to the distribution system by means of two electrically driven pumps. The pressure in the system is regulated by two-250 gallon pressure tanks.

The supply is not treated. The bacteriological quality of the water has been satisfactory.

As indicated by the following analyses, the water is quite hard with an appreciable iron content.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	pH at Lab.	Chloride as Cl	M.F. Coliforms per 100 ml
422	376	0.6	7.6	34	0

The main problem has been routine maintenance and operation of the system. The provision of a suitable water rate structure will facilitate the recovery of operation and maintenance costs and ensure continuity of operation.

(b) Glen Lawrence

The Glen Lawrence water works, owned and operated by Mr. J. Harvey, serves 13 homes. Water is obtained from a two-inch diameter intake which extends about 80 feet into the St. Lawrence River to an average depth of 20 feet. Storage is provided by three pressure tanks with a total capacity of 1,250 gallons. The distribution mains consist of two-inch diameter galvanized iron pipes.

Treatment consists of disinfection using an electrically driven hypochlorinator.

Problems with intermittent turbidity and algae are encountered. These characteristics result in visually unattractive water which may exhibit taste and odours.

Water quality is normal for the St. Lawrence River; however, recognition should be given to the fact that the intake is located about one mile downstream from the City of Kingston sewage treatment plant. In view of this, operation of the system should be carefully controlled and supervised.

The following laboratory results for bacteriological and chemical quality as sampled on June 16, 1964, indicate medium hardness and a high coliform content. The coliform count affirms the need for strict control of disinfection and routine testing and sampling programmes.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chloride as Cl	pH at Lab.	Apparent Colour Units
134	98	0.1	21	8.6	5

Turbidity Units	M.F. Coliforms per 100 ml
2.6	9,600

(c) Milton or Sweezey

The Milton Subdivision water works supplies four homes and obtains water from the river by means of a four-inch diameter intake pipe. The pipe extends some 175 feet from shore into a water depth of five feet.

Water is disinfected by an electrically driven hypochlorinator. Storage is provided by means of a 15,000-gallon elevated wooden tank. In addition to the river supply some of the homes employ private drilled wells.

The water quality is similar to that noted for the Glen Lawrence water works. Since the intake is located three-quarters of a mile downstream from the Glen Lawrence system the effect of sewage effluent discharges from the City of Kingston are probably less significant.

The bacteriological and chemical quality of the raw water is evident by the following data.

Hardness as $CaCO_3$	Alkalinity as $CaCO_3$	Iron as Fe	Chloride as Cl	pH at Lab.	M.F. Coliforms per 100 ml
136	100	0.1	25	8.0	19

The analysis indicate that the water was of relatively good bacteriological quality at the time of sampling, although it can be expected that this will show considerable variation. Careful control and supervision of routine operation of this system is essential.

(d) Joyceville Institution

In the past, water supply for the Joyceville Institution has been obtained from three wells. Due to limited quantity of ground water available, a new surface supply has been provided.

The new plant includes coagulation, filtration, and chlorination, and obtains water from the Rideau waterway by means of a 12-inch diameter intake pipe. The intake extends 50 feet from shore and the inlet is located in a water depth of four and one-half feet.

The average daily water consumption for 1963 was 101,000 gallons.

The following summary of water quality for the ground-water and surface-water supplies is presented.

	Jan.22, 1963 Ground Water	Oct.28, 1962 Rideau Waterway
Hardness as $CaCO_3$	414	91
Alkalinity as $CaCO_3$	280	76
Iron as Fe	0.05	0.14
pH at Lab.	7.2	7.8
Chloride as Cl	36	5.2
Fluoride as F	0.6	0.1
Colour as Hazen Units		20
Turbidity as Silica Units		4

The ground water is very hard and has a significant fluoride content. The surface water is of medium hardness and exhibits notable colour characteristics. Colour can be reduced by the treatment process.

3. Potential Additional Supplies

(a) Ground Water

Future domestic needs may be satisfied in some areas by water supplies available from the bedrock. In addition, supplies for small communities appear to be obtainable from the limestone and sandstone aquifers. As previously noted the quality of water from the limestone may be poor, particularly in the south-western section of the township. Supplies from the Precambrian bedrock do not appear to be sufficient to support community requirements. Overburden deposits are thin and generally only capable of satisfying limited domestic needs.

(b) Surface Water

The preferred source of municipal water is the St. Lawrence River. Because of variations in discharge, temperature, and water quality, the Cataraqui River is less desirable as a source of supply.

4. Future Requirements

Probably the most economical method of supplying areas of existing and future needs in the township would be to extend the supply from the city which feeds the army camp. Such an arrangement would require the formulating of a satisfactory agreement between the township, the Department of National Defence, and the City of Kingston.

The alternative of a separate township water works system would require location of a filtration plant upstream from the outfall of the Kingston sewage treatment plant.

III WATER POLLUTION

1. Sewage Treatment Facilities

The only municipal sewage treatment plant in the township is owned and operated by the city. As indicated, this plant serves the city and the military camp.

The location of the Kingston sewage treatment plant is suited for servicing the developed area of the township. The mutual use of one large sewage treatment plant would provide economy of operation and probably more effective treatment.

Sewage disposal in subdivisions other than the Cana Co-operative is provided by private septic tanks and subsurface systems. The lack of suitable soil and the proximity of rock to the surface in most areas precludes the effective operation of septic tank tile beds. Due to the fractured nature of the limestone, sewage effluent readily seeps away and may result in contamination of ground water.

Cana Co-Operative Home Builders Subdivision and Joyceville Institution operate private sewage treatment facilities.

(a) Cana Co-Operative Home Builders

The Cana Co-Operative system consists of three septic tanks and an underdrained tile bed with effluent discharge to a small drain tributary to the Cataraqui River. The system, designed for 100 persons, serves 32 homes in the subdivision. In the past this system has not been satisfactorily maintained and operated. Improvements in operation are proposed.

(b) Joyceville Institution

All sewage at the Joyceville Institution is discharged to a secondary treatment plant of the activated sludge type. The plant receives sanitary sewage and process waste from a canning factory and a slaughterhouse located on the grounds. The sewage treatment plant, designed for a population of

900 and an average daily flow of 113,000 gallons, discharges chlorinated effluent into a marsh which drains to the Cataraqui River. The plant now serves 700 persons with an average daily flow of 80,000 gallons. The treatment efficiency on the basis of samples submitted in 1964 is 84 and 73 per cent for BOD and suspended solids removal, respectively.

Operational problems have been experienced with the high oxygen demand of the canning factory and slaughterhouse wastes. Pre-treatment of the slaughterhouse wastes is expected to improve operation, although re-evaluation of the effects of canning wastes is required.

2. Industrial Waste Disposal

There are no industrial waste problems.

3. Refuse Disposal

Refuse disposal is provided by private contractors or by the individual homeowner. The refuse collected from the military camp is disposed of at the City of Kingston disposal area.

4. Surface Water Quality

Water quality information for the Cataraqui River, Rideau waterway, and the St. Lawrence River is contained in Tables 3-7 and 3-8. Water quality impairment is indicated in the lower Cataraqui River downstream of Belle Island. This section of the river is in the City of Kingston and is discussed in that section of the report.

The quality of the St. Lawrence River, as it pertains to the township, has been discussed as well under the chapter dealing with the City of Kingston.

5. Future Requirements

The development of future subdivisions should only be allowed on the basis of sewers and sewage treatment. Priority should be given to the area on Highway 2 east of the military camp. In order to determine a suitable service area, a preliminary engineering report outlining the boundaries of the water and sewage areas should be prepared.

Joint arrangements for sewage treatment between the township and the city would require similar investigation.

IV CONCLUSIONS

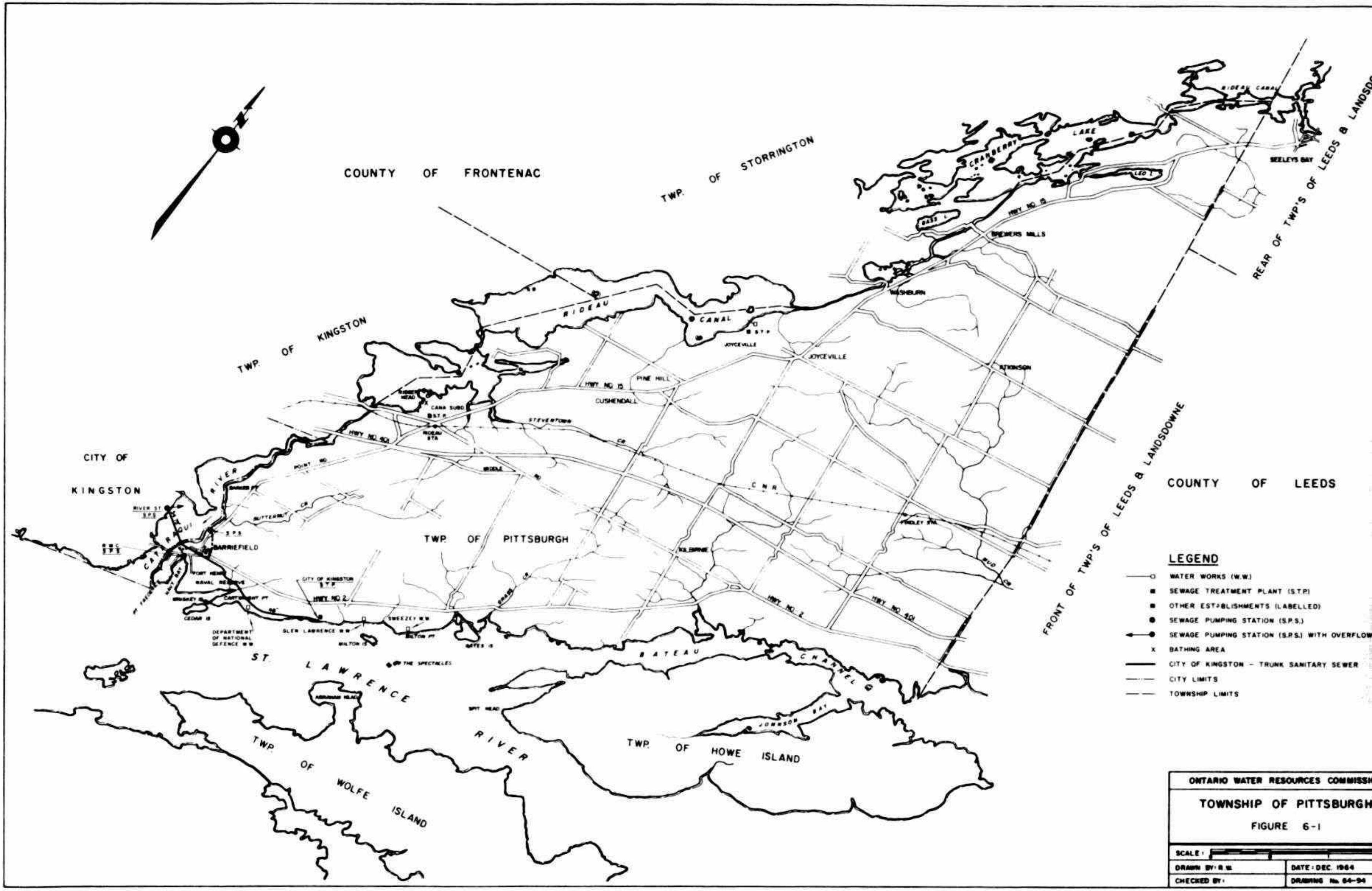
1. Water Supply

Development in the Township of Pittsburgh requires the provision of municipal water supply facilities. As ground-water resources are limited, the use of the St. Lawrence River for supply purposes should be considered.

The possibility of obtaining water service from the City of Kingston for the areas of greatest need in the township should be investigated. A suitably located filtration plant would provide an alternative to water supply from the city.

2. Pollution Control

In order to abate the present pollution of ground water, sanitary sewers should be installed in the developed sections of the township. Consideration should be given to the feasibility of developing sewage treatment arrangements jointly with the City of Kingston. Utilization of one sewage treatment plant for both municipalities would ensure improved protection of the St. Lawrence River and contribute to economies in operation. Future subdivisions should only be allowed on the basis of a public sewerage system.


COUNTY OF FRONTENAC
TWP. OF STORRINGTON
TWP. OF KINGSTON
CITY OF KINGSTON
TWP. OF PITTSBURGH
COUNTY OF LEEDS
REAR OF TWP'S OF LEEDS & LANSDO
FRONT OF TWP'S OF LEEDS & LANSDOWNE
RIDEAU CANAL
CRANBERRY LAKE
SEELEYS BAY
BREWERS MILLS
WASHBURN
JOYCEVILLE
ATKINSON
PINE HILL
CUSHENDALL
HWY NO 15
HWY NO 401
HWY NO 2
C N R
BARRIEFIELD
CATARAQUI RIVER
BATEAU CHANNEL
JOHNSON BAY
ST. LAWRENCE RIVER
TWP. OF HOWE ISLAND
TWP. OF WOLFE ISLAND
LEGEND
WATER WORKS (W.W.)
SEWAGE TREATMENT PLANT (S.T.P.)
OTHER ESTABLISHMENTS (LABELLED)
SEWAGE PUMPING STATION (S.P.S.)
SEWAGE PUMPING STATION (S.P.S.) WITH OVERFLOW
BATHING AREA
CITY OF KINGSTON - TRUNK SANITARY SEWER
CITY LIMITS
TOWNSHIP LIMITS
ONTARIO WATER RESOURCES COMMISSI
TOWNSHIP OF PITTSBURGH
FIGURE 6-1
SCALE:
DRAWN BY: R.W.
DATE: DEC. 1964
CHECKED BY:
DRAWING No. 64-94

CHAPTER 7

TOWNSHIPS OF BARRIE, CLARENDON AND MILLER, PALMERSTON AND NORTH AND SOUTH CANONTO

CHAPTER 7

TOWNSHIPS OF BARRIE, CLARENDON AND MILLER, PALMERSTON AND NORTH AND SOUTH CANONTO

I GENERAL

These municipalities are sparsely populated and are likely to remain so. The respective populations of the townships for 1964 are noted.

Barrie	409
Clarendon and Miller	458
Palmerston and North and South Canonto	349

The tourist industry has the greatest potential for development in these municipalities. It is to be expected that greater demands will be made on the available water for domestic and recreational uses during the summer season.

II WATER SUPPLY

1. Township of Barrie

(a) General

Privately owned dug, driven and drilled wells supply the residents of the township with adequate to good yields of water. The dug and driven wells are essentially concentrated within a narrow sand and gravel deposit extending from the community of Bon Echo to the community of Bishop's Corners at the western township boundary. Due to the lack of overburden throughout much of the township, drilled rock wells are the most common sources of supply. Penetration of the wells ranges from 20 to 190 feet, with most terminating at depths of less than 50 feet. Reportedly, fresh, good quality water is obtained from all wells in the township.

(b) Potential Additional Supplies

Ground water adequate for the needs of a communal system appears to be present within the sand and gravel deposit which ranges to a depth of 200 feet at the communities of Bon Echo and Cloyne. In general, yields suitable only for domestic purposes are obtainable from the bedrock. It may be possible to obtain sufficient water from bedrock to

supply a municipal system in the vicinity of Harlowe. A ground-water survey would be required to appraise adequately the water-yielding possibilities of the aquifers at these communities.

Surface water is available in many areas of the townships; however, it would require adequate treatment prior to use for potable purposes.

2. Townships of Clarendon and Miller

(a) General

Water supplies for local residents in the townships are obtained from dug and drilled wells. Most wells are drilled and penetrate the bedrock to various depths ranging up to 234 feet. Adequate yields of good quality water are obtained.

The few dug wells are located in shallow sand and gravel deposits near lakes and streams, with the greatest concentration of such wells being near Plevna. Shortages in supplies of some dug wells have occurred during summer periods, but in general, such supplies have been adequate for domestic needs.

(b) Potential Additional Supplies

Supplies for additional domestic requirements are available throughout the township from bedrock and overburden aquifers.

Ground-water supplies adequate for municipal purposes do not appear to be present in most sections of the township. The best possibilities for larger yields are in the Plevna area within the bedrock and the sand and gravel deposits associated with Buckshot Creek. A ground-water survey would be required to assess aquifer conditions in these areas.

The available surface water would require adequate treatment prior to use for potable purposes.

3. Townships of Palmerston and North and South Canonto

(a) General

Residents in the townships obtain water supplies from dug and drilled wells.

Dug wells are the common source of supply at the communities of Snow Road and Mississippi Station where sand and gravel deposits at depths in excess of 20 feet are reported.

Throughout the remainder of the townships, overburden deposits are thin, requiring that wells be drilled into bedrock to obtain adequate supplies. Depths of penetration are variable ranging from 30 to 100 feet. The better yields are obtained generally at depths less than 50 feet.

The quantity of water obtained from all wells is sufficient to meet present domestic needs.

(b) Potential Additional Supplies

Additional supplies for domestic use are available from the bedrock.

Sufficient supply for a communal system may be obtainable from the bedrock in the vicinity of the communities of Ompah and Snow Road. A ground-water survey would be required to outline the more favourable test-drilling areas.

The available surface water in the area would require adequate treatment before domestic use.

III WATER QUALITY

There have been no reported pollution problems in these municipalities. This can be attributed to the limited population and lack of commercial and industrial developments.

The following results of two bacteriological samples obtained from area surface waters indicate satisfactory quality.

Source	Date	M.F. Coliforms per 100 ml
Mississippi River at Snow Road Station	July/64	63
Clarendon Lake, Coxdale	July/64	66

IV CONCLUSIONS

The townships are sparsely populated and lack major commercial and industrial developments. This is reflected in the generally satisfactory surface-water quality.

Waters for domestic consumption are obtained from individual ground-water supplies, which apparently are adequate for present needs. Additional supplies for individual requirements may be obtained from bedrock and overburden aquifers in certain areas.

Community water works using surface supplies may be developed, provided the waters are treated adequately. Similarly, ground-water supplies,generally satisfactory for small communal systems, may be available at Bon Echo, Cloyne, Harlowe, Plevna, Ompah, and Snow Road, and in the vicinity of Buckshot Creek.

CHAPTER 8

TOWNSHIPS OF BEDFORD AND HINCHINBROOKE

CHAPTER 8

TOWNSHIPS OF BEDFORD AND HINCHINBROOKE

I GENERAL

The resident populations of the townships of Bedford and Hinchinbrooke are 667 and 1,044 persons respectively. A marked increase occurs during the summer season because of the recreational potential of the many lakes and streams within these municipalities. This is particularly true of the Township of Bedford.

II WATER SUPPLY

1. Township of Bedford

(a) General

Water supplies in the township are obtained from springs and dug and drilled wells.

Most dug wells are located in the vicinity of the communities of Fermoy and Burridge within shallow sand and gravel deposits. Supplies from these wells are generally adequate for domestic needs.

Many drilled wells penetrate the bedrock to various depths ranging up to 128 feet. Most wells intercept less than 100 feet of bedrock. Adequate yields of good quality fresh water are reportedly obtained.

(b) Potential Additional Supplies

Additional ground-water supplies for domestic purposes are available from the bedrock aquifer throughout the township.

Yields obtained in certain areas of the township indicated that supplies adequate to meet the needs of small community systems may be present within the bedrock. If the need for such a system arises, a ground-water survey would be required to evaluate potential supplies.

The available surface water would require adequate treatment prior to domestic use.

2. Township of Hinchinbrooke

(a) General

All supplies are obtained from springs and dug and drilled wells. The use of dug wells is limited to areas where the depth of overburden is substantial.

As the overburden is generally thin, drilled rock wells are the most common source of supply. The depth of bedrock penetration ranges from 31 to 184 feet, and generally is less than 100 feet. Adequate to good domestic yields of fresh quality water are normally obtained from all wells.

(b) Potential Additional Supplies

Additional ground-water supplies for domestic purposes are available from the bedrock throughout the township.

The largest communities in the township are Tichborne, Parham, and Godfrey. In the event that a communal water system is required at any of these locations, it appears that limited supplies may be available from the bedrock. In addition, the overburden deposits in the Parham area may also be capable of yielding sufficient water supplies, although the depth and extent of these deposits were not determined during the survey. Water throughout the township is generally of potable quality; however, caution should be exercised when drilling wells in the Tichborne area as some salty water may be encountered. Known cases of contamination may be due to salting of highways and not a natural condition.

There are many good surface waters available which could be utilized as sources of communal supply. These should receive adequate treatment prior to domestic use.

It is to be expected that the storage potential of Depot Creek will be utilized more fully by the construction of control dams and reservoirs on the Napanee River. This will improve the average flow in the Napanee River which is used as a source of supply for the Town of Napanee.

II WATER QUALITY

Due to limited population and related commercial and industrial development, the possibility of pollution is minimal. Water quality at selected sampling locations is indicated following.

Source	Date	M.F. Coliforms per 100 ml
Bobs Lake at Bobs Lake	July/64	90
Devils Lake at road east of shoreline	July/64	226
Buck Lake at narrows between North and South Bay, off County Road	July/64	3,900

The one industry, Parham Cheese Factory, is located in the Township of Hinchinbrooke. Process waste from this plant is discharged to a septic tank and the effluent drains to a nearby ditch. In view of the inadequate wastewater treatment provided by the factory, an improved method of waste disposal is required.

IV CONCLUSIONS

Ground-water supplies for individual premises are adequate in capacity and quality.

Future supplies for communal systems may be obtainable from the many lakes and streams, and to a limited extent, from bedrock aquifers and overburden deposits.

Water pollution of domestic origin is limited because of the comparatively small populations of the townships. Except for the Parham Cheese Factory no other sources of industrial pollution are known.

CHAPTER 9

TOWNSHIPS OF HOWE ISLAND AND WOLFE ISLAND

CHAPTER 9

TOWNSHIPS OF HOWE ISLAND AND WOLFE ISLAND

I GENERAL

Lying in the St. Lawrence River, the townships of Howe Island and Wolfe Island are mostly rural in nature with agriculture being the main industry. The islands also have a limited number of summer homes. Access to the islands is by means of ferries which carry vehicular traffic.

The populations are given below for 1964.

Township of Howe Island	220
Township of Wolfe Island	1,136

II WATER SUPPLY

1. Township of Howe Island

(a) General

Residents in the township obtain supplies for domestic and farm uses from shallow dug and drilled wells.

Most dug wells terminate on the bedrock surface as the overburden thickness seldom exceeds 10 feet. Water shortages have frequently occurred in these wells during dry summer periods. This has necessitated drilling deeper rock wells in several areas to obtain a more constant supply. The quality of water from the bedrock is variable ranging from fresh to sulphurous and salty. Adequate to good quantities of water are obtained from these wells.

(b) Potential Additional Supplies

Adequate quantities of ground water for additional domestic and farm needs can be obtained from the limestone aquifer, but quality will be a problem in many areas.

As the population has remained static in recent years the need for a community water system has not been established. There is some possibility that adequate supplies could be obtained from the bedrock. Care would need to be employed in selection of potential well sites to avoid encountering highly mineralized water.

Surface water from the St. Lawrence River would require adequate treatment prior to use.

2. Township of Wolfe Island

(a) General

Water supplies for domestic and farm use in the township are obtained from dug and drilled wells.

As the overburden is thin and generally clayey in composition, most wells extend into bedrock to obtain adequate supply. Depth of penetration is varied and ranges from 29 to 124 feet. Adequate supplies of water are reportedly obtained from some of these wells, although many dry wells have been drilled particularly in the central region of the island. The quality of water from the bedrock aquifer is generally poor with a high mineral content.

Dug wells are generally poor sources of supply especially during summer drought periods, although the water is fresh.

(b) Potential Additional Supplies

Additional supplies to meet the demands of future domestic and rural growth are available locally from the bedrock, but the quality will be generally poor.

In the event that a water system becomes feasible for the community of Wolfe Island, a ground-water survey would be required to determine the possibility of obtaining potable water from the local bedrock. The sand and gravel deposit located about two miles east of the community appears to have substantial thickness and may present a potential source of supply.

Surface water available from Lake Ontario and the St. Lawrence River would require adequate treatment prior to domestic use.

III WATER QUALITY

In the Township of Wolfe Island a water pollution problem associated with wastes discharged from the Kraft Foods Limited Cheese Factory has been corrected by the installation of a spray irrigation system.

River water in the vicinity of Cone Point on Wolfe Island has indicated satisfactory bacteriological quality.

IV CONCLUSIONS

Water for domestic and farm uses is obtained from shallow dug and drilled wells. The dug wells frequently dry up and the deeper drilled wells produce water ranging from fresh to sulphurous and salty. These factors should be considered in the selection of additional well sites.

The waters of Lake Ontario and the St. Lawrence River require treatment before use as sources of supply.

Pollution of surface waters is not significant on and adjacent to the islands. The only major industrial establishment, Kraft Foods Limited Cheese Factory, employs a spray irrigation system for industrial waste disposal.

CHAPTER 10

TOWNSHIPS OF KENNEBEC, OLDEN, AND OSO

CHAPTER 10

TOWNSHIPS OF KENNEBEC, OLDEN, AND OSO

I GENERAL

These municipalities are sparsely populated. Highway 7 divides the Townships of Kennebec, Olden and Oso in nearly equal parts. This road and Highway 38 provide ready tourist access to many of the lakes in the area. The tourist industry represents one of the main sources of revenue for the district. The largest community is Sharbot Lake.

The township populations for 1964 follows.

Township of Kennebec	706
Township of Olden	663
Township of Oso	1,127

II WATER SUPPLY

1. Township of Kennebec

(a) General

Water supplies in the township are obtained from private wells.

Thin overburden, in the order of four to five feet, overlies bedrock throughout much of the township. Thicker deposits of till or sand and gravel are present within some depressions.

In areas of thin overburden, wells are drilled into the bedrock to obtain water supplies. Penetrations vary from 30 to 160 feet, with better yields obtained from horizons shallower than 100 feet. Fresh, good quality water is reportedly obtained.

Most wells in the communities of Arden and Henderson are dug and penetrate the overburden to a depth of 10 to 12 feet. Adequate domestic supplies of good quality are obtained.

(b) Potential Additional Supplies

Adequate to good supplies sufficient to satisfy additional domestic needs are available throughout the township from the bedrock aquifer and overburden deposits.

At the more populated communities the bedrock aquifer is relatively poor and does not appear to be capable of supplying large quantities except possibly at Arden. A substantial deposit of sand and gravel appears to be present at Arden which may be capable of supplying the community. A ground-water survey would be required to ascertain these possibilities.

Adequate surface-water supplies are available in sections of the township. Should these be developed for potable purposes, it would be necessary to provide adequate treatment.

2. Township of Olden

(a) General

Nearly all residents obtain water supplies from dug and drilled wells.

Most wells are drilled into the bedrock due to the general lack of overburden. Penetrations are variable ranging from 29 to 150 feet. Adequate to good domestic yields are reportedly obtained. The better yields appear to be obtained at depths less than 50 feet.

Most wells in the Mountain Grove area are dug and penetrate a local sand and gravel deposit to depths ranging up to 25 feet. About 100 feet of overburden material is reportedly present at this community. Good yields of water are obtained.

The quality of water is good except in certain local areas where high iron concentrations are present in some supplies.

(b) Potential Additional Supplies

Adequate supplies for domestic use are available from the bedrock aquifer throughout the township.

Most of the township population is concentrated in the Mountain Grove area. A supply sufficient for community needs may be obtainable from either the bedrock or the overburden sand and gravel. A ground-water survey would be required to locate the best test-drilling areas.

The available surface water would require adequate treatment prior to use.

3. Township of Oso

(a) General

A small municipal water works is located in the community of Sharbot Lake. The water is pumped untreated from Sharbot Lake to a hotel and house. In addition, this water is used to supply many of the local household cisterns. Consideration is now being given to installing a chlorinator on this supply.

In all other areas of the township water supplies are obtained from private wells. The majority of wells are drilled into bedrock as much of overburden is thin, usually in the order of five feet. Bedrock penetrations vary from 30 to 176 feet, with most wells terminating at depths less than 100 feet. Adequate to good yields of fresh water are obtained from such wells.

Dug wells generally provide an adequate supply, but shortages have been reported during dry summer periods.

(b) Potential Additional Supplies

Adequate supplies for domestic use can be obtained from the bedrock and shallow overburden aquifers.

There appear to be no overburden aquifers within the township capable of supporting a communal system. In the event that Sharbot Lake requires such a system, it is possible that adequate supplies could be obtained from the bedrock. A ground-water survey would be required to evaluate this possibility.

Sharbot Lake would serve as a good source of supply but would require adequate treatment for municipal purposes.

III WATER QUALITY

Water pollution is not a serious problem, although local sources of water quality impairment resulting from defective private sewage disposal systems may exist.

Surface-water quality, as evidenced by the following bacteriological data, is generally satisfactory.

Source	Date	M.F.Coliforms per 100 ml
Sharbot Lake at Highway 38	July/64	18
Long Lake at Long Lake	July/64	36

IV CONCLUSIONS

Individual ground-water supplies are used throughout the townships. Additional supplies may be developed in certain areas. The surface waters may also be employed for water supply, but these require treatment.

CHAPTER 11

TOWNSHIP OF LOUGHBOROUGH

CHAPTER 11

TOWNSHIP OF LOUGHBOROUGH

I GENERAL

The main industries of the township are agriculture and tourism. Due to its relative proximity to the city some of the residents commute daily to Kingston.

The population of the township was 2,038 persons in 1964.

II WATER SUPPLY

1. General

The sources of water supply are springs and dug and drilled wells. Limited overburden makes it necessary to drill into the bedrock for most supplies.

Wells drilled in the central and northern sections of the township penetrate the Precambrian bedrock. The depth of penetration is varied and ranges from 33 to 261 feet. Adequate to good yields of fresh water are reportedly obtained from the drilled wells.

Wells drilled in the southern section terminate in Palaeozoic limestone. The depth of penetration is generally in the order of 70 feet, with a range from 27 to 240 feet. Generally adequate yields of water are obtained although several wells drilled in the Railton area encountered no water.

In general, it appears that the yield of water from the Precambrian bedrock is slightly better than that from the Palaeozoic bedrock.

The quality of ground water from bedrock is good throughout the township, except in the Sydenham area where some salty water has been encountered.

Dug wells generally are not reliable sources of supply, particularly during the summer periods, and are not in common use.

2. Potential Additional Supplies

Additional ground-water supplies for domestic and farm purposes are available from the bedrock. In addition, ground-water conditions in the bedrock in the Sydenham area appear to be such that a small community system could possibly be supplied. A ground-water survey would be required to properly assess the possibilities of potential sites.

Overburden deposits in the township have poor aquifer potentialities and appear capable only of supplying domestic needs.

For the community of Sydenham water may be obtained from Lake Sydenham. However, for such use, adequate water treatment facilities would be required.

III WATER QUALITY

In general, the quality of surface waters throughout the township is satisfactory. Problems due to pollution from malfunctioning or inadequate private sewage disposal systems do arise; however, the extent of the pollution is limited.

The results of samples obtained from lakes in the township are noted below.

Source	Date	M.F.Coliforms per 100 ml
Sydenham Lake at Sydenham Park Beach	July/64	162
Millhaven Creek at outlet of Sydenham Lake	Aug./62	52
	Sept/63	0
	July/64	22
Millhaven Creek at Sydenham-Harrowsmith Road	Aug./62	12,700
	Sept/63	470
	July/64	2,400
Millhaven Creek at Murvale	July/64	2

The periodic adverse conditions on Millhaven Creek are likely due to inadequate or malfunctioning private sewage disposal systems in Sydenham.

IV CONCLUSIONS

Water for individual supplies is obtained mainly from wells drilled into the bedrock. These wells are of adequate yield and quality, except in the Sydenham area, where salty water has been encountered. Additional ground-water supplies for domestic and farm purposes are available from the bedrock formations.

Millhaven Creek at the community of Sydenham has indicated periodic pollution which may be due to malfunctioning sewage disposal systems.

Surface-water supplies, if developed for domestic uses, would require treatment.

CHAPTER 12

TOWNSHIP OF PORTLAND

CHAPTER 12

TOWNSHIP OF PORTLAND

I GENERAL

Highway 38 traverses the length of the township and the main communities of Harrowsmith and Verona are located along it. The main industries are agriculture and tourism. In addition, a cheese factory is located at Harrowsmith. Many of the township residents commute daily to jobs in the Kingston area.

The population of the township was 3,382 persons in 1964.

II WATER SUPPLY

1. General

Water supplies in the township are obtained from springs and dug, drilled, and driven wells.

The majority of the wells are drilled into bedrock with penetrations ranging from 23 to 244 feet. The better wells are generally less than 50 feet in depth. In the northern section of the township such wells penetrate the Precambrian bedrock and obtain adequate to good yields of fresh water.

In the central and southern sections of the township most of the drilled wells terminate in the limestone. Yields from this aquifer range from poor to good. Quality is variable with many wells reportedly obtaining salty or sulphurous water.

At Verona, many individual water supplies are obtained from driven and drilled wells ending in the overburden which consists of sand and gravel of varied thicknesses up to 60 feet.

2. Potential Additional Supplies

Supplies sufficient for domestic needs are available in most areas from bedrock or the overburden where substantial thicknesses exist. Supplies adequate for community needs may be obtained from the deep sand and gravel aquifer at Verona.

Ground-water conditions at Harrowsmith may be suitable for a community water system but care would be required in locating test-drilling sites as some areas of poor quality water are present.

There is no readily available surface-water supply for the community of Harrowsmith. In the case of Verona, a municipal supply could be obtained from Verona Lake. Such a supply would require adequate treatment.

III WATER QUALITY

The surface-water quality in the township is satisfactory as evidenced by the following sample results.

Source	Date	M.F. Coliforms per 100 ml
Napanee River near Petworth	July/64	14
Napanee River at Hwy. 38 south of Verona	July/64	9
Cameron Creek south of Bellrock	July/64	82
Verona Lake at creek from Howes Lake	July/64	93

At the Harrowsmith Cheese Factory a spray irrigation system is employed for waste disposal. The wastes are sprayed on a five-acre tract of land south-east of the community. Careful operation of the disposal system must be maintained to control the possibility of surface and ground-water pollution.

IV CONCLUSIONS

The existing water supplies consist of wells which produce waters of variable quality and quantity. The more satisfactory supplies are located in the northern section of the township, where the majority of wells are drilled into Precambrian bedrock. In the central and southern sections most of the wells terminate in limestone bedrock except at Verona, where many are constructed in sand and gravel deposits. Some of the well sites may be satisfactory for supplying the needs of communities. In the case of Verona, Verona Lake may be used as an alternative source if the water is treated.

The results of surface water samples indicate satisfactory conditions. At the Harrowsmith Cheese Factory, the main industry in the township, a spray irrigation system is used for process waste disposal. Care is required in operation of the system to control water pollution.

CHAPTER 13

TOWNSHIP OF STORRINGTON

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TOWNSHIP OF STORRINGTON

I GENERAL

There are no provincial highways located in the township. The two main county roads are the Perth Road and Battersea Road. On these routes are located the communities of Battersea, Inverary, and Sunbury.

In addition to the agriculture and tourist activities, two cheese factories are located at Battersea and Sunbury.

II WATER SUPPLY

1. General

Throughout the township water supplies are obtained from privately owned dug and drilled wells.

Most drilled wells are completed in the bedrock due to the lack of substantial overburden. Three distinct rock aquifers are present: the Precambrian sequence, the Potsdam sandstone, and the Black River limestone. Adequate to good yields of fresh water are usually obtained from the three aquifers. A few occurrences of salty and sulphurous water have been reported from the limestone.

Dug well supplies are generally fair, with some shortages occurring during summer periods. The quality of water from these wells is usually satisfactory.

2. Potential Additional Supplies

The bedrock throughout most of the township is capable of yielding adequate supplies to meet future domestic demands. In addition, ground-water conditions at Battersea and Inverary appear to be such that a small community system could be supported from the bedrock aquifer. A ground-water survey would be required to outline the better areas with respect to yield and quality, particularly at Inverary where some poor quality water has been encountered.

Surface water for community supply needs is not readily available at Inverary or Sunbury. Such a supply is available at Battersea providing adequate treatment facilities are provided.

III WATER QUALITY

Wastes from the Battersea Cheese Factory are discharged without treatment to Millburn Creek which is tributary to Dog Lake. This has caused pollution of the creek and odour complaints from nearby residents. The amount of flow in the creek is controlled by a small diameter hole located in the dam adjacent to the factory. A satisfactory method of waste disposal is required at this factory.

Wastes are discharged from the Sunbury Cheese Factory to Bear Creek, which is a tributary of the Rideau waterway. This has resulted in pollution of the creek. A satisfactory method of waste disposal should be installed at this factory.

The results of samples obtained from certain surface waters are noted below.

Source	Date	M.F.Coliforms per 100 ml
Loughborough Lake near Loughborough Inn	July/64	3,700
Collins Lake outlet at north end	July/64	164

The reason for the high coliform report on Loughborough Lake requires further investigation.

IV CONCLUSIONS

Water supplies obtained from wells generally yield adequate quantities. Additional supplies appear to be available throughout most of the township. At the community of Battersea a community system could be developed using surface water.

Improved methods of industrial waste disposal at the Battersea and Sunbury Cheese factories are required.

APPENDIX

EXPLANATION & SIGNIFICANCE OF LABORATORY ANALYSES

All of the laboratory tests included in this report were performed at the Ontario Water Resources Commission Laboratory in Toronto.

A. BACTERIOLOGICAL EXAMINATION

Bacteriological examinations were performed on samples from water supplies, streams, and outfalls. The Membrane Filter Technique was used to obtain a direct enumeration of coliform organisms. These organisms are normal inhabitants of the intestines of man and other warm blooded animals, and to some extent the upper soil level. They are always present in large numbers in sewage and are generally minimal in other stream pollutants.

The results of the examinations are reported as "M. F. Coliform Count per 100 ml".

The objective for stream sanitation is a coliform density of not greater than 2,400 organisms per 100 ml.

B. STREAM AND OUTFALL SAMPLES

The chemical analyses performed on stream and outfall samples include determinations for biochemical oxygen demand, suspended solids, turbidity, and in some instances, pH, and alkyl benzene sulfonate (ABS).

BIOCHEMICAL OXYGEN DEMAND (BOD):

Biochemical oxygen demand is reported in ppm and is an indication of the amount of oxygen required for the stabilization of decomposable organic matter present in sewage, polluted waters, or industrial wastes. The completion of the laboratory test requires five days, under the controlled incubation temperature of 20°C.

The objective for stream water quality is an upper limit of 4 ppm.

SOLIDS:

The laboratory carries out tests to determine the total and suspended solids in a sample The value of dissolved

solids is determined by taking the mathematical difference between the total and suspended solids.

The concentration of suspended solids expressed in parts per million (ppm) is generally the most significant of the solids analyses in regard to stream water quality. The effects of suspended solids in water are reflected in difficulties associated with water purification, deposition in streams, and injury to the habitat of fish.

Where suspended solids values approach 20 ppm or less, laboratory difficulties are experienced and, excepting the samples from sewage treatment works, the values of suspended matter are usually determined as turbidity.

TURBIDITY:

Turbidity is caused by the presence of suspended matter, such as clay, silt, finely divided organic matter, plankton, and other microscopic organisms in water. It is an expression of the optical property of a sample and results are reported in "Silica Units".

pH:

The pH is an index of the acidity or alkalinity of the solution as represented by the instantaneous hydrogen ion concentration. The practical pH scale extends from 0, very acid, to 14, very alkaline, with the middle value of pH 7 corresponding to exact neutrality (at 25°C.). The objectives for surface-water quality as adopted by the OWRC suggest that the pH of the waters following initial dilution, should not be less than 6.7 nor greater than 8.5.

C. WATER SUPPLIES

The chemical analyses performed on water used as a source of supply for municipal or private systems include; hardness, alkalinity, chlorides, iron, fluoride, pH, turbidity, and colour.

HARDNESS:

No specific limit is usually placed on hardness although it is usually recommended that waters for domestic use should contain less than 250 ppm hardness as $CaCO_3$. This recommended limit has been used to avoid excessive soap consumption and other problems, primarily economic, usually associated with

hard water. The degrees of hardness are indicated as:

Soft	-	0-75 ppm as $CaCO_3$
Moderately Hard	-	75-150 ppm as $CaCO_3$
Hard	-	150-300 ppm as $CaCO_3$
Very Hard	-	greater than 300 ppm as $CaCO_3$

ALKALINITY:

Alkalinity of natural waters is due to the presence of salts of weak acids, usually bicarbonates. The concentration is reported in ppm as $CaCO_3$ and is significant in determining aggressive tendencies and softening treatment requirements.

CHLORIDES:

Chlorides are naturally present, in varying concentrations, in water supplies. Increasing chloride concentration may indicate contamination from domestic sewage.

The recommended maximum concentration to avoid saline tastes is 250 ppm.

IRON:

The recommended maximum limit for iron in water supplies is 0.3 ppm. It is noted that waters with concentrations of iron in excess of 0.3 ppm are not harmful to consumers but have objectionable staining and sediment-forming properties, and may cause the deposition of iron in pipes or the growth of iron bacteria. If the concentration exceeds 1 ppm, problems with metallic taste may occur.

FLUORIDE:

Fluoride may occur naturally in water or it may be artificially applied at the supply and/or treatment works.

A fluoride concentration of approximately 1 ppm is considered beneficial in the prevention of dental caries. The recommended maximum and minimum limits of fluoride are 1.2 ppm and 0.8 ppm respectively.

TURBIDITY:

The significance of turbidity is included in Section B.

The turbidity of treated water should not exceed 5 Silica Units.

COLOUR:

The colour intensity of water is reported in Hazen Units.

The colouration of natural water may result from contact with organic matter or chemical substances.

The recommended maximum colour content is 15 Hazen Units.

FREE AMMONIA:

Free ammonia represents the first product of decomposition of organic matter and thus appreciable concentrations of free ammonia usually indicate "fresh pollution" of sanitary significance.

Low	-	0.015 to 0.03 ppm
Moderate	-	0.03 to 0.10 ppm
High	-	0.10 or higher ppm

TOTAL DISSOLVED SOLIDS:

The effect of total dissolved solids influences taste and the laxative properties of a water supply. A limit of 500 ppm is used.

NITRATE:

Nitrate levels are specified, as excessive concentrations may cause methemoglobinemia in infants. A limit of 45 ppm nitrate is specified as the upper limit.